# *Challenges of Using Environmental Indicators for Performance Measurement*

Jay Messer
Senior Science Advisor
National Center for Environmental Assessment

May 18, 2004

# *Performance Measurement*

**“ My goals for the Agency are to make our air cleaner, our water purer and our land better protected. These are the results that we are working hard to achieve. Our progress towards these goals will be the measure of our success.** ***To know whether we are making progress toward these goals, we need high quality information about the state of the environment. –***

***Christine Todd Whitman, November, 2001***

# Government Performance and Results Act (GPRA)

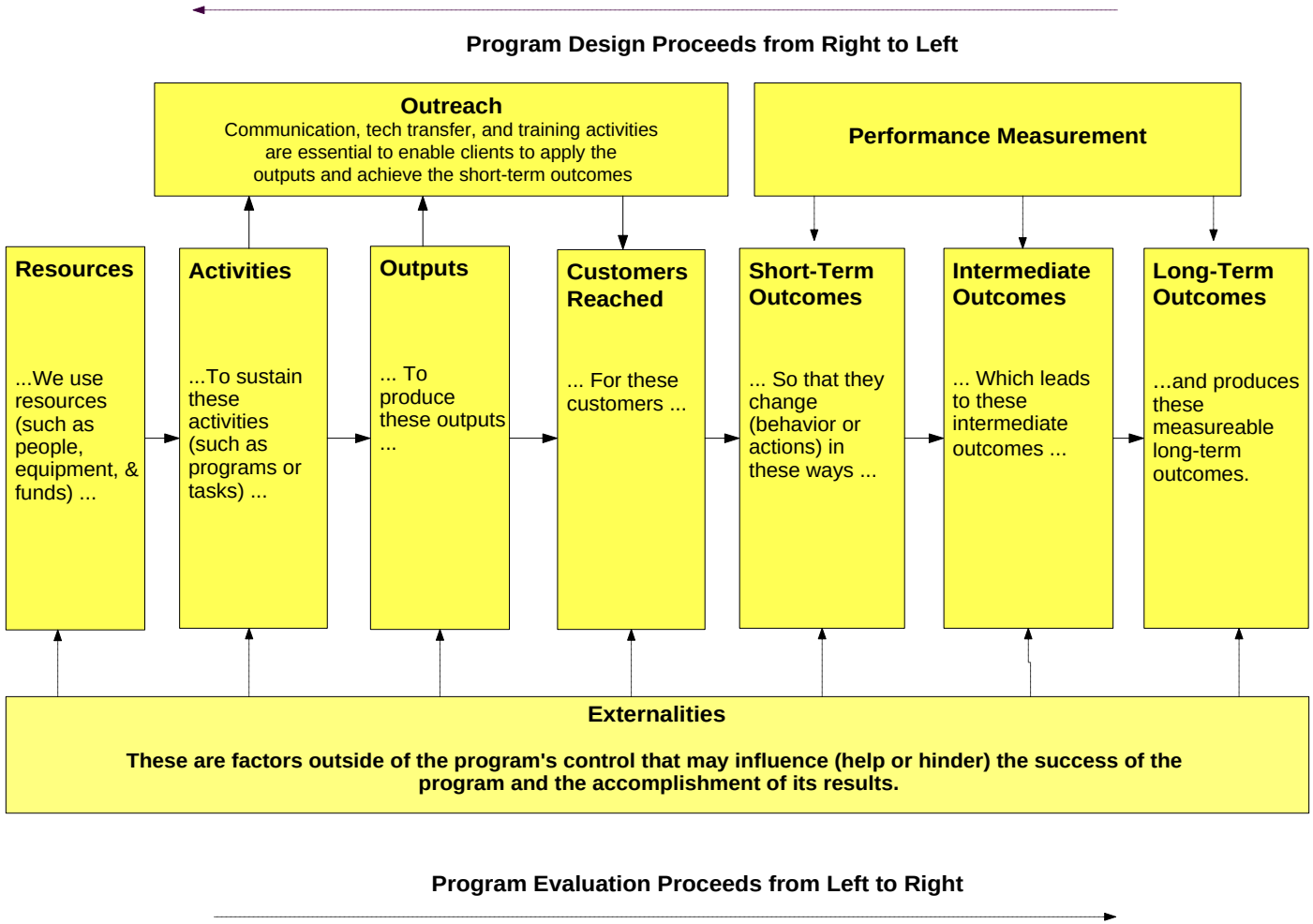
**Sec. 1115. Performance plans**

- "(a) In carrying out the provisions of section 1105(a)(29), the Director of the Office of Management and Budget shall require each agency to prepare an annual performance plan covering each program activity set forth in the budget of such agency. Such plan shall-
- "(1) establish performance goals to define the level of performance to be achieved by a program activity;
- "(2) express such goals in an objective, quantifiable, and measurable form unless authorized to be in an alternative form under subsection (b);
- "(3) briefly describe the operational processes, skills and technology, and the human, capital, information, or other resources required to meet the performance goals;
- "(4) establish performance indicators to be used in measuring or assessing the relevant outputs, service levels, and outcomes of each program activity;
- "(5) provide a basis for comparing actual program results with the established performance goals; and
- "(6) describe the means to be used to verify and validate measured values.

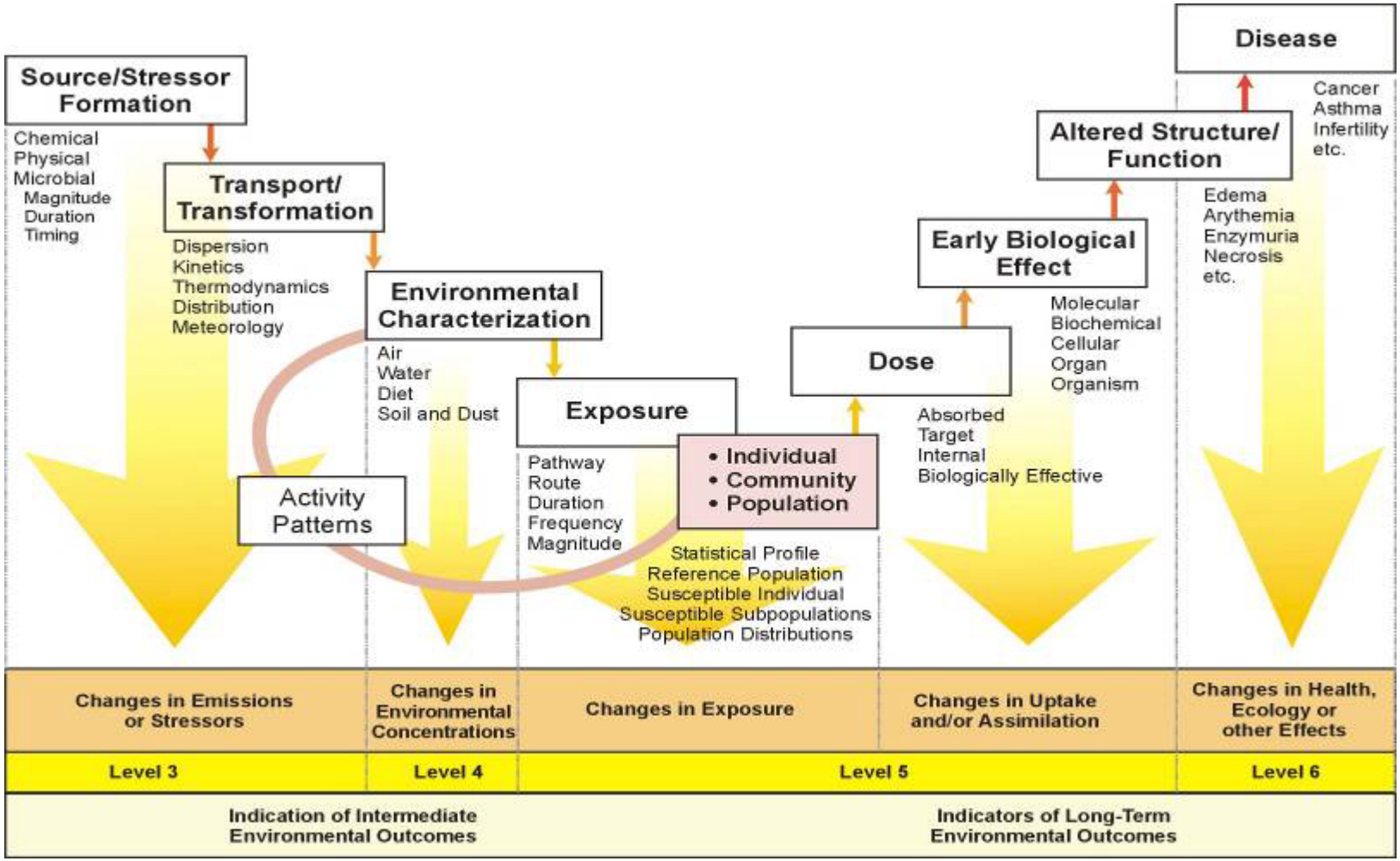
# Government Performance and Results Act (GPRA)

- Establish performance goals to define the level of performance to be achieved by a program activity
- Express goals in an objective, quantifiable, and measurable form
- Describe the processes, skills and technology, and the resources required to meet the goals
- Establish performance indicators to be used in measuring or assessing the relevant outputs, service levels, and outcomes of each program activity
- Provide a basis for comparing actual program results with the established performance goals
- Describe the means used to verify and validate the measured values

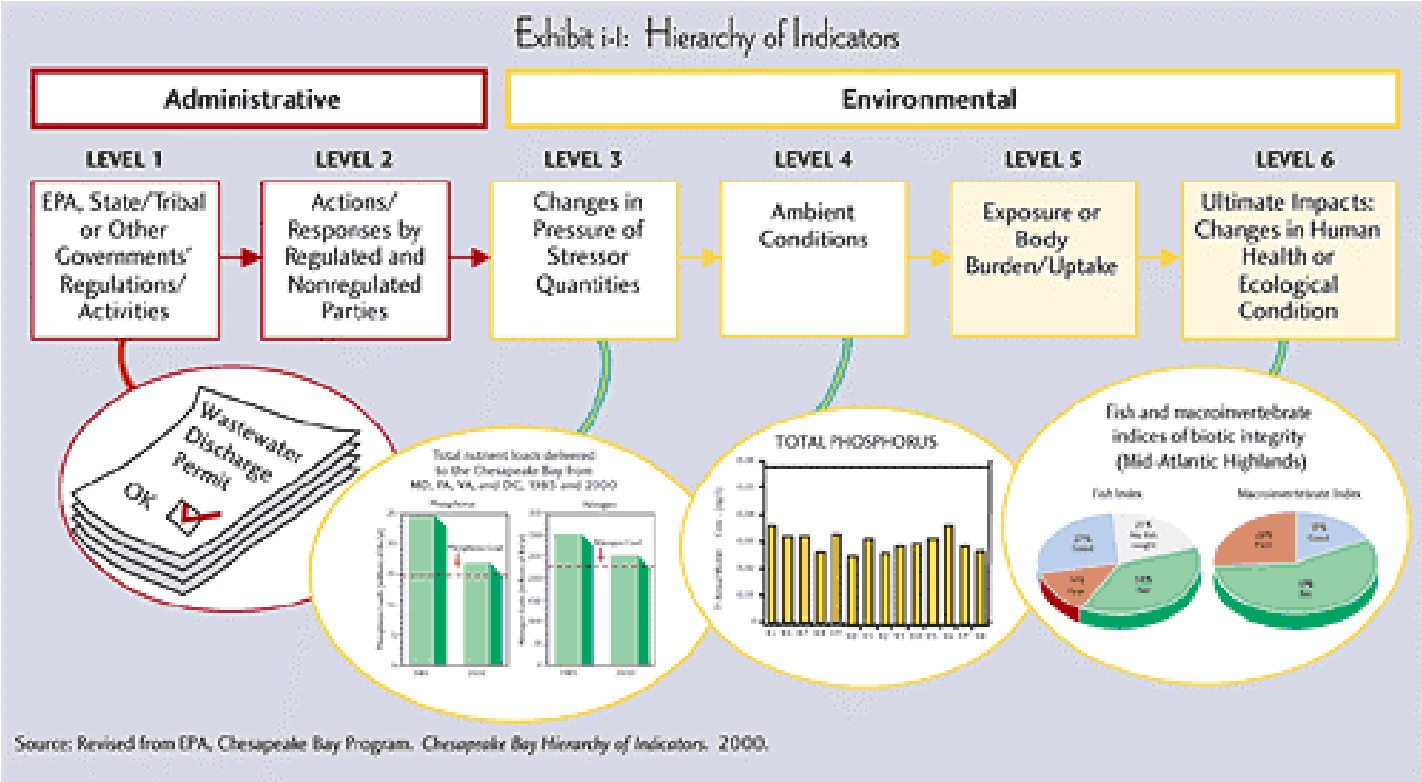
# The Logic Model



# The Risk Model



# Performance indicators



# *Major challenges to performance indicators*

- Performance indicators that are not credible
- Performance data that are not timely
- Absence of performance data

# *Challenges to the credibility of performance indicators*

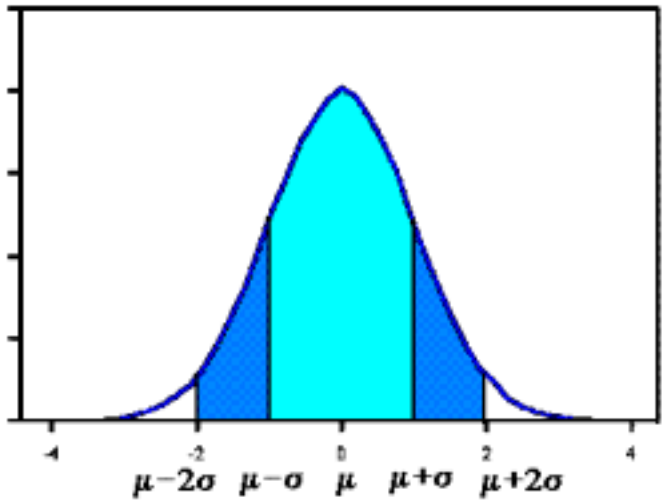
- Cause versus coincidence in "outcome" indicators
- Comparable, representative data
- Transparency
- Reference thresholds
- Appropriate scale for the issue
- Data quality and access

# *Cause versus coincidence in "outcome" indicators*

- Most environmental regulations not based on technology are based on reducing the risk of an adverse outcome (level 6)
- Many other factors affect level 6 outcome indicators
- Statistical detection may be difficult if exposed populations are small and we lack markers of exposure

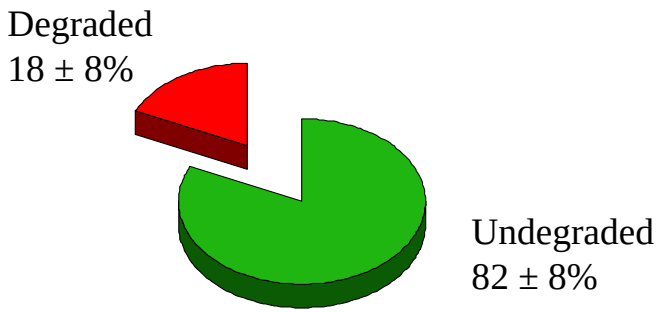
# *Cause versus coincidence in "outcome" indicators*

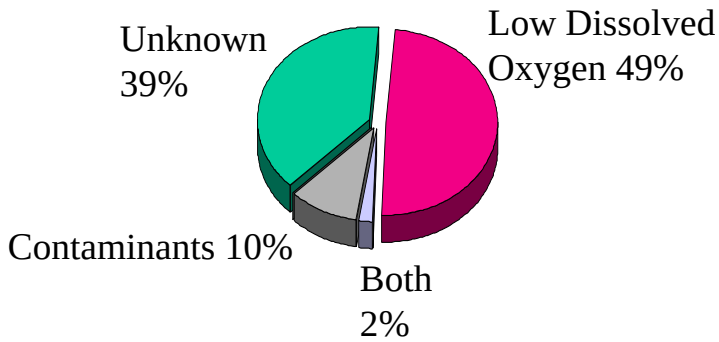
- Dublin, Ireland – an exceptional story



# Estuarine Conditions in MAIA

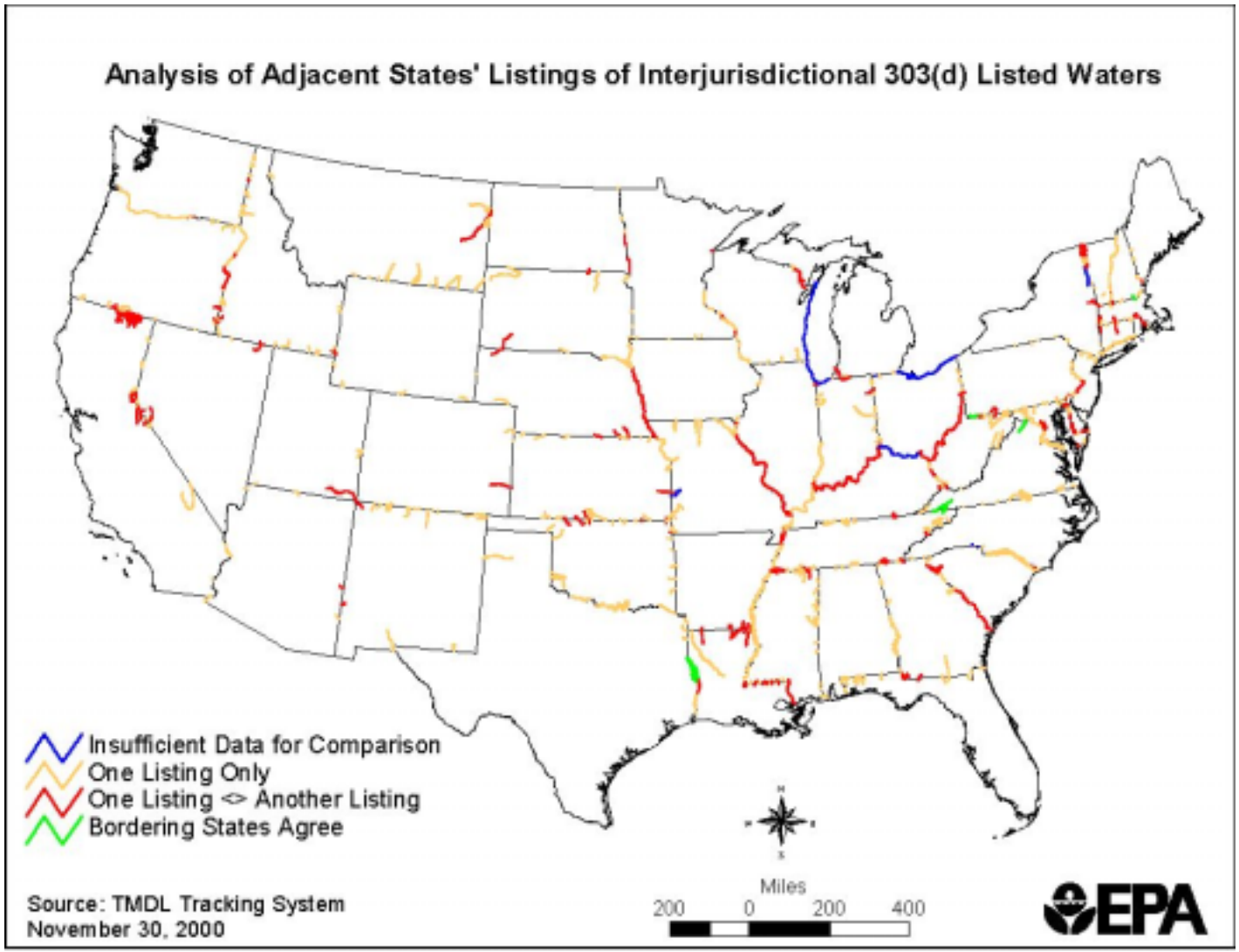
Benthic Invertebrate Index of Biotic Integrity (IBI)



# *Comparable, representative data*

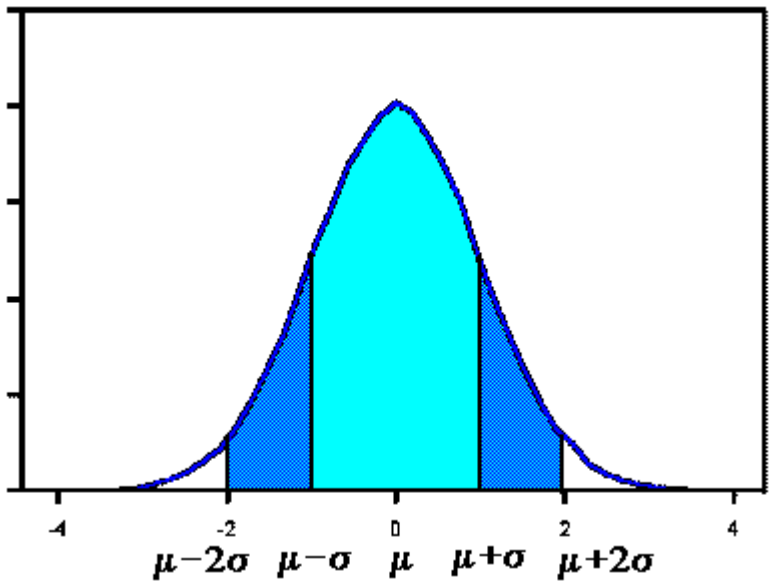
- Many monitoring data are not intended to measure performance outcomes.
  - Compliance with regulations
  - Managing health care
  - Resource management
  - Research


Analysis of Adjacent States' Listings of Interjurisdictional 303(d) Listed Waters
Insufficient Data for Comparison
One Listing Only
One Listing <> Another Listing
Bordering States Agree
Source: TMDL Tracking System
November 30, 2000
Miles
200
0
200
400
EPA

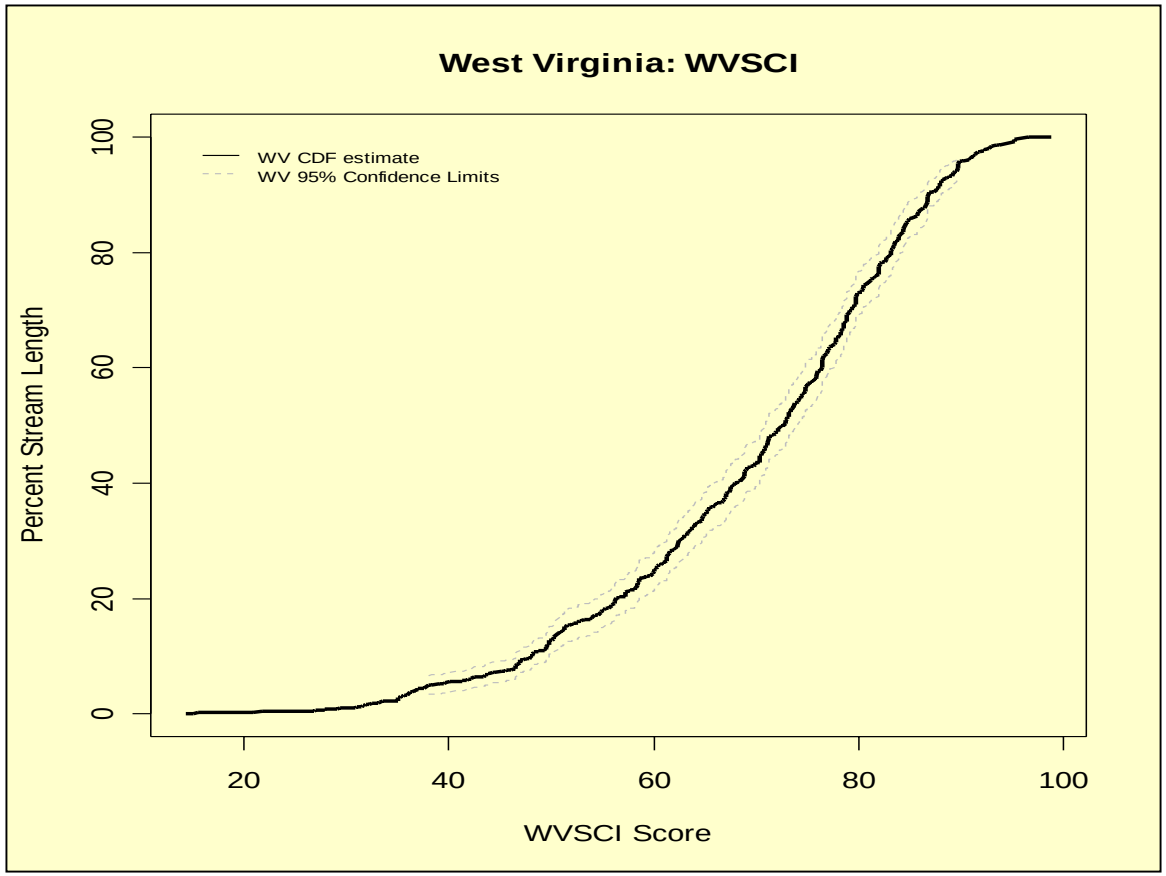
# *Comparable, representative data require:*

- Clearly identified target population
- Sample representative of target population
- Data collected with the same protocol (or for which there is a basis for comparison)
- Trends over time

# Probability sampling

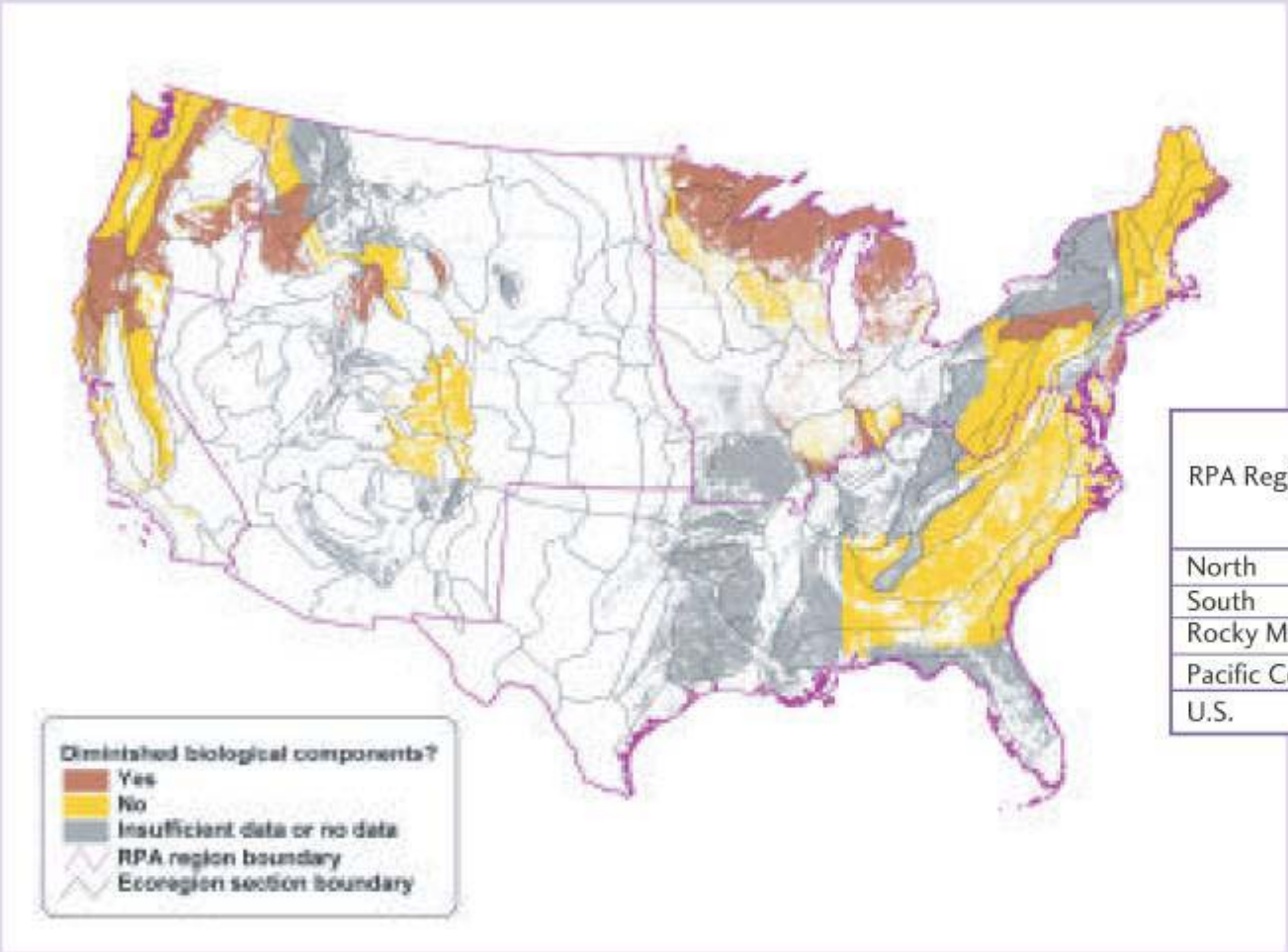


# Probability sampling provides confidence estimates



# *Some examples*

# Exhibit 5-11: Tree condition, 1990-1999



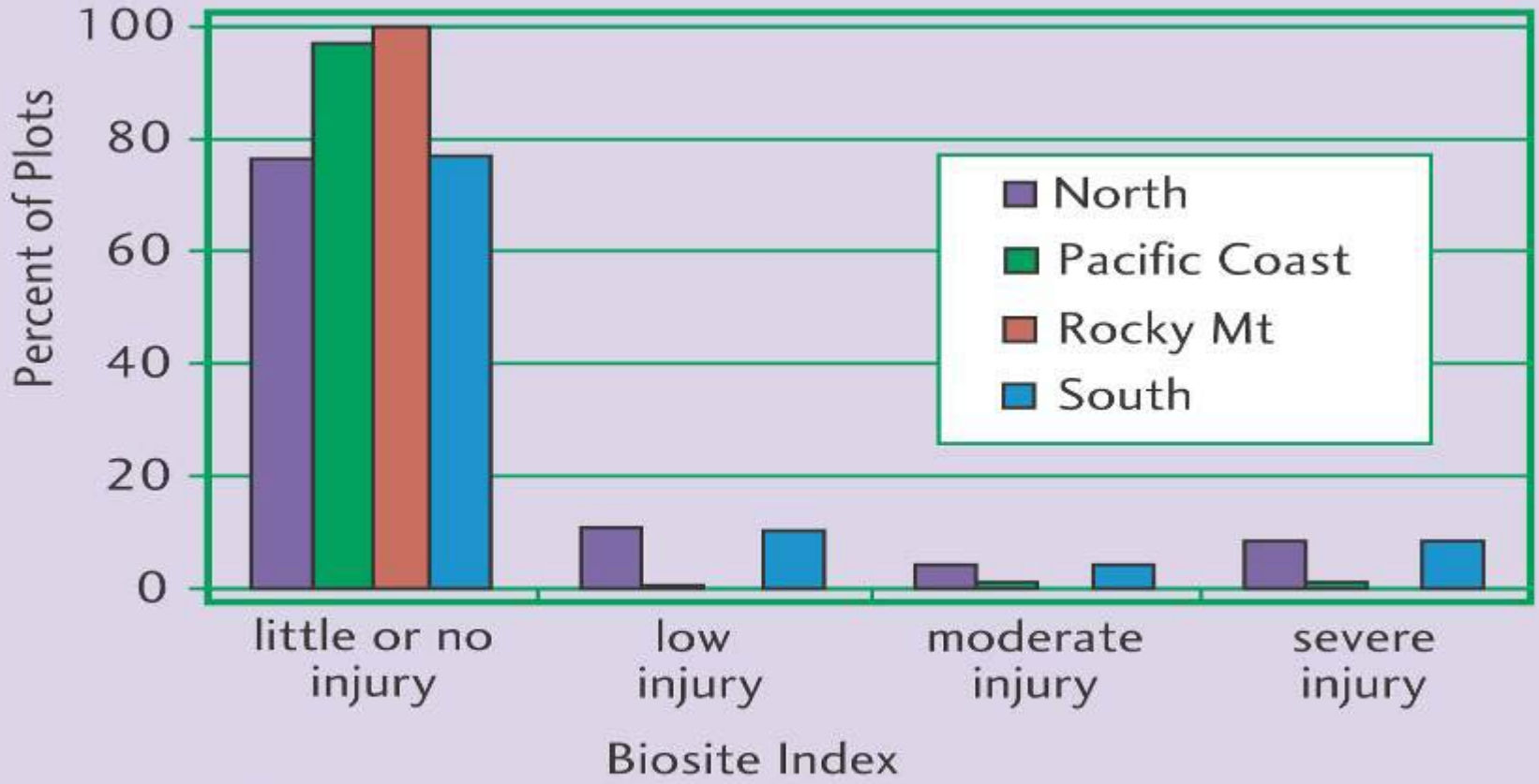

| RPA Region | Diminished Biological Components? | | |
|---|---|---|---|
| | Yes | No | No or Insufficient Data |
| | percent | | |
| North | 33.1 | 37.1 | 29.8 |
| South | 0.0 | 43.1 | 56.9 |
| Rocky Mtn. | 18.5 | 29.2 | 52.3 |
| Pacific Coast | 40.5 | 59.5 | 0.0 |
| U.S. | 20.3 | 40.9 | 38.8 |

Coverage: 32 states.

Forest area having diminished biological components that may indicate changes in fundamental ecological processes and/or ecological continuity. Percentages based on forest area in conterminus 48 States.

Source: Conkling, B., et al. *Forest Health Monitoring National Technical Report 1991-1999*. 2002.

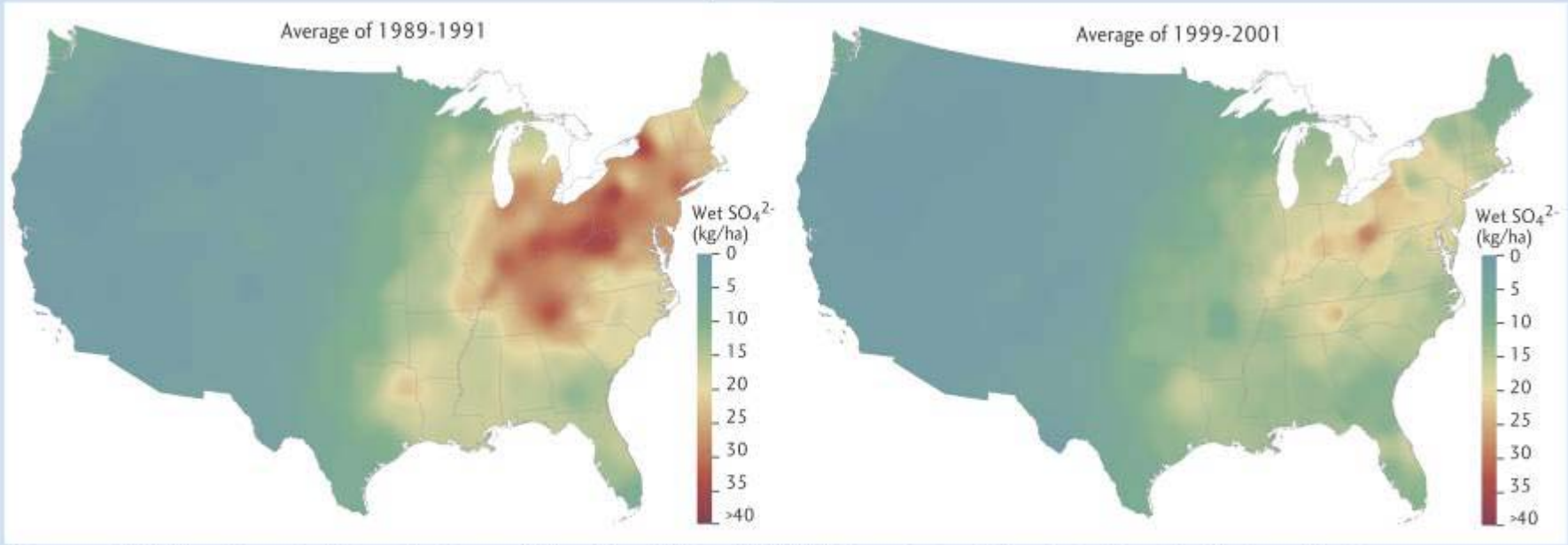
# Exhibit 5-12: Ozone injury to trees, 1994-2000




Coverage: 32 states.

Source: USDA, Forest Service. *National Report on Sustainable Forests - 2003. Final Draft.* 2002.

## Exhibit 1-22: Wet sulfate deposition, 1989-1991 vs. 1999-2001

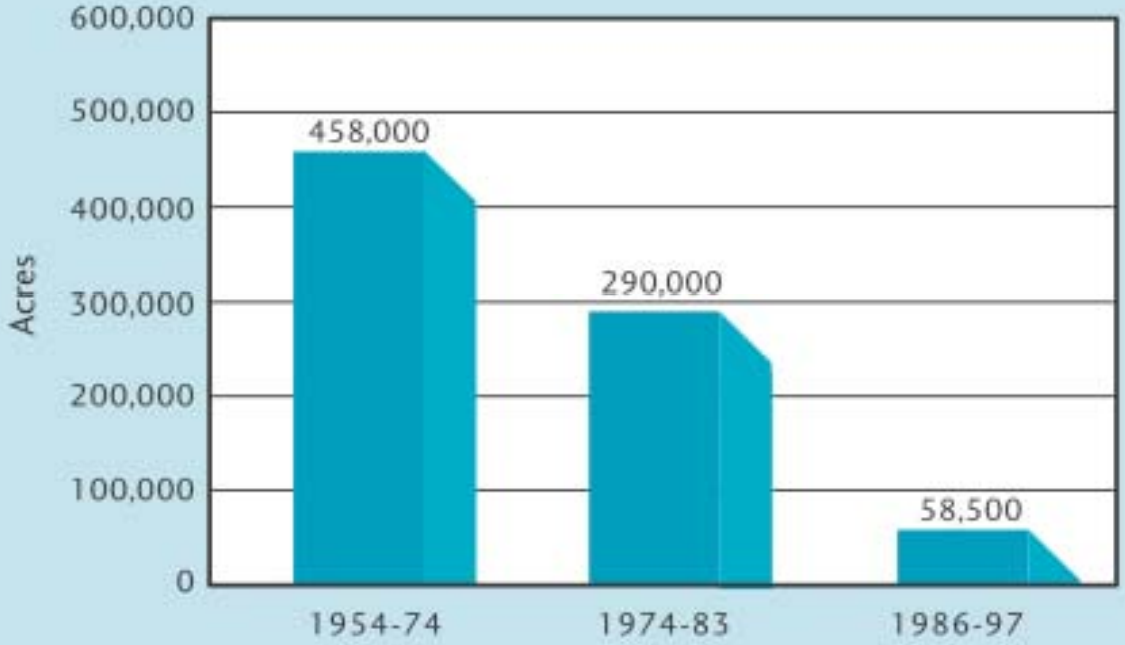



Coverage : 250 National Atmospheric Deposition Program National Trends Network (NADP/NTN) monitoring stations located throughout the lower 48 states.

Note: Map colors represent relative concentrations and do not imply ecological or human health status

Source: EPA, Office of Air and Radiation, Clean Air Markets Program. *EPA Acid Rain Program: 2001 Progress Report*. November 2002.

# Exhibit 2-5: Average annual wetland loss, 1954-1974, 1974-1983, 1986-1997



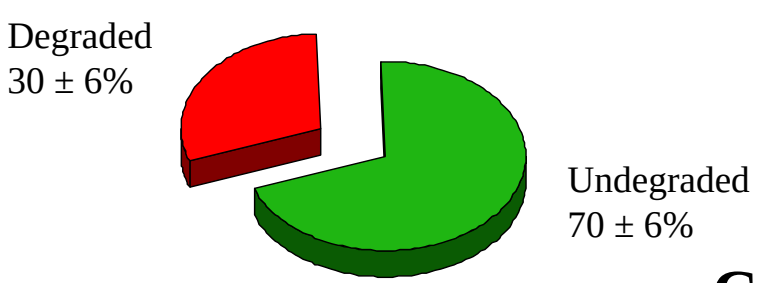

Coverage: Conterminous United States

Source: Frayer et al. *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950s to 1970s.* 1983; Dahl, T.E. and C. E. Johnson. *Wetlands Status and Trends in the Conterminous United States: 1970s to 1980s.* 1991; Dahl, T. E. *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997.* 2000.

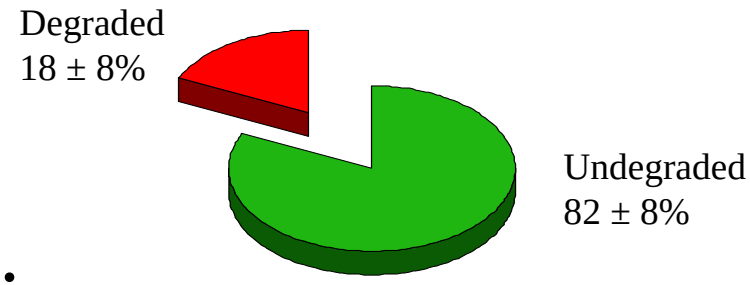
# Comparison of Estuarine Conditions

## Estuarine Benthic Invertebrate IBI

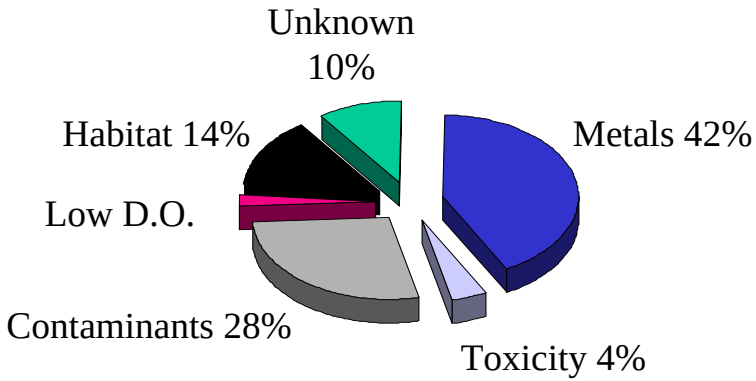
### Louisianian Province

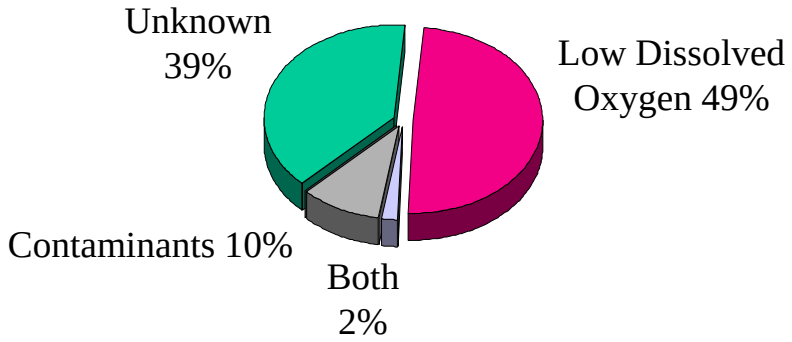



### Virginian Province




**Condition**

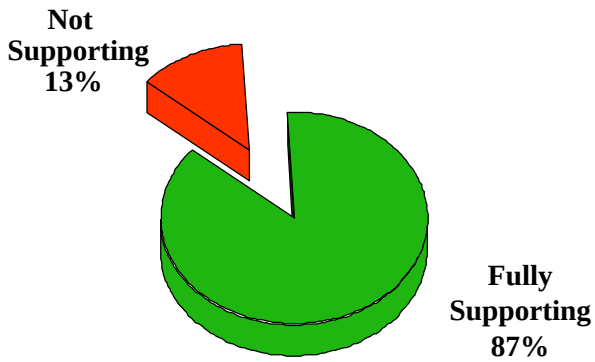



**Stressors Associated with Degraded Condition**

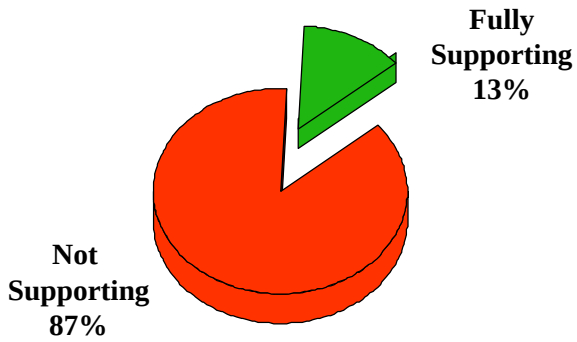
# Representative Sampling

## Condition of a streams using different designs

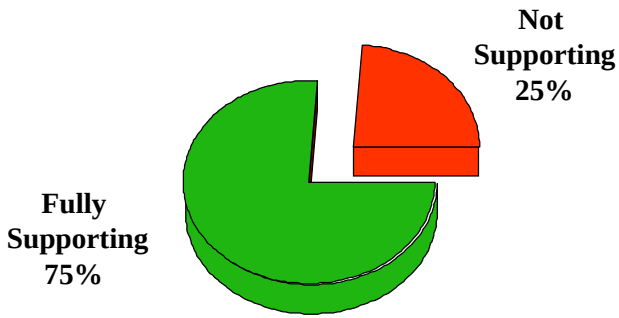



Traditional Targeted Monitoring

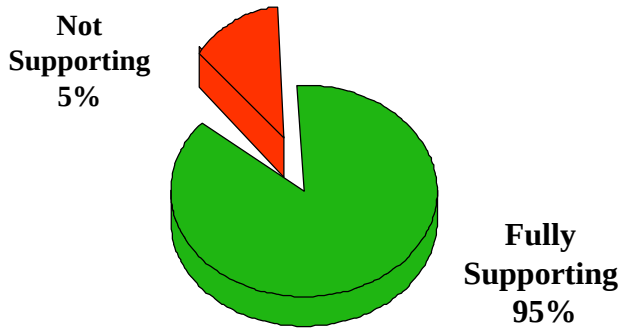
**State "A"**




Probability Survey

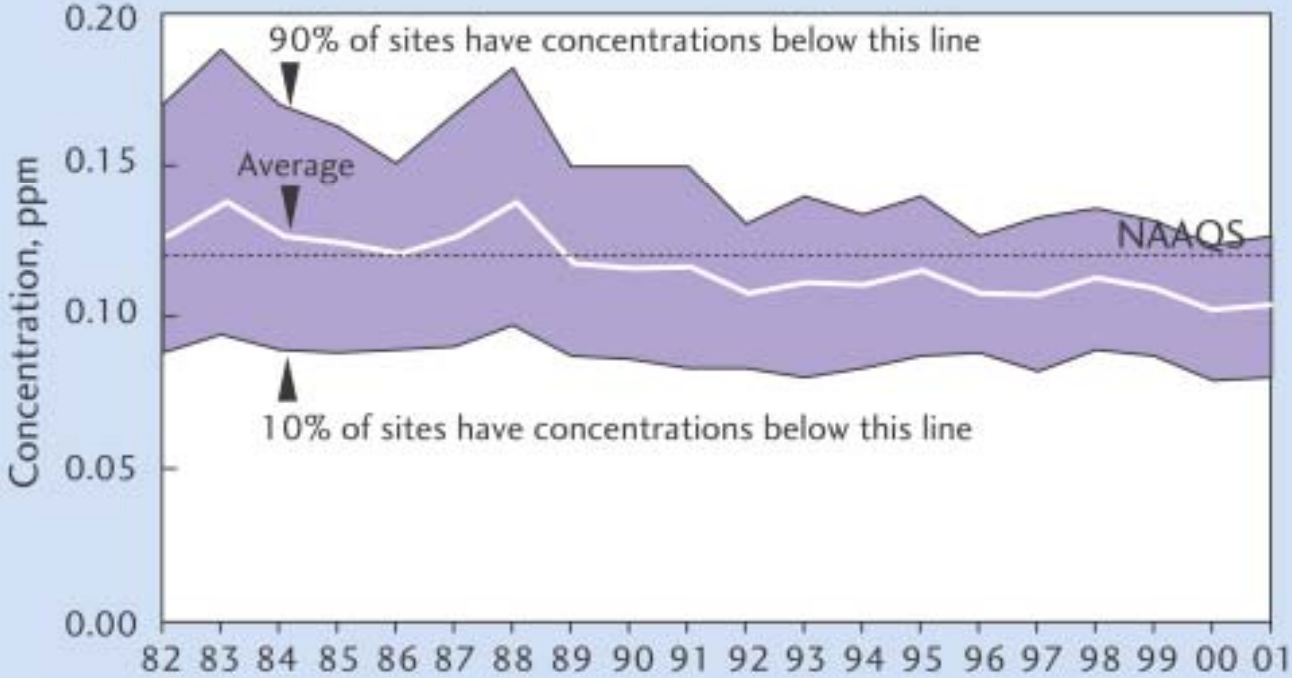



**State "B"**



# Exhibit 1-10: Ozone air quality, 1982-2001

## based on annual 2nd maximum 1-hour average



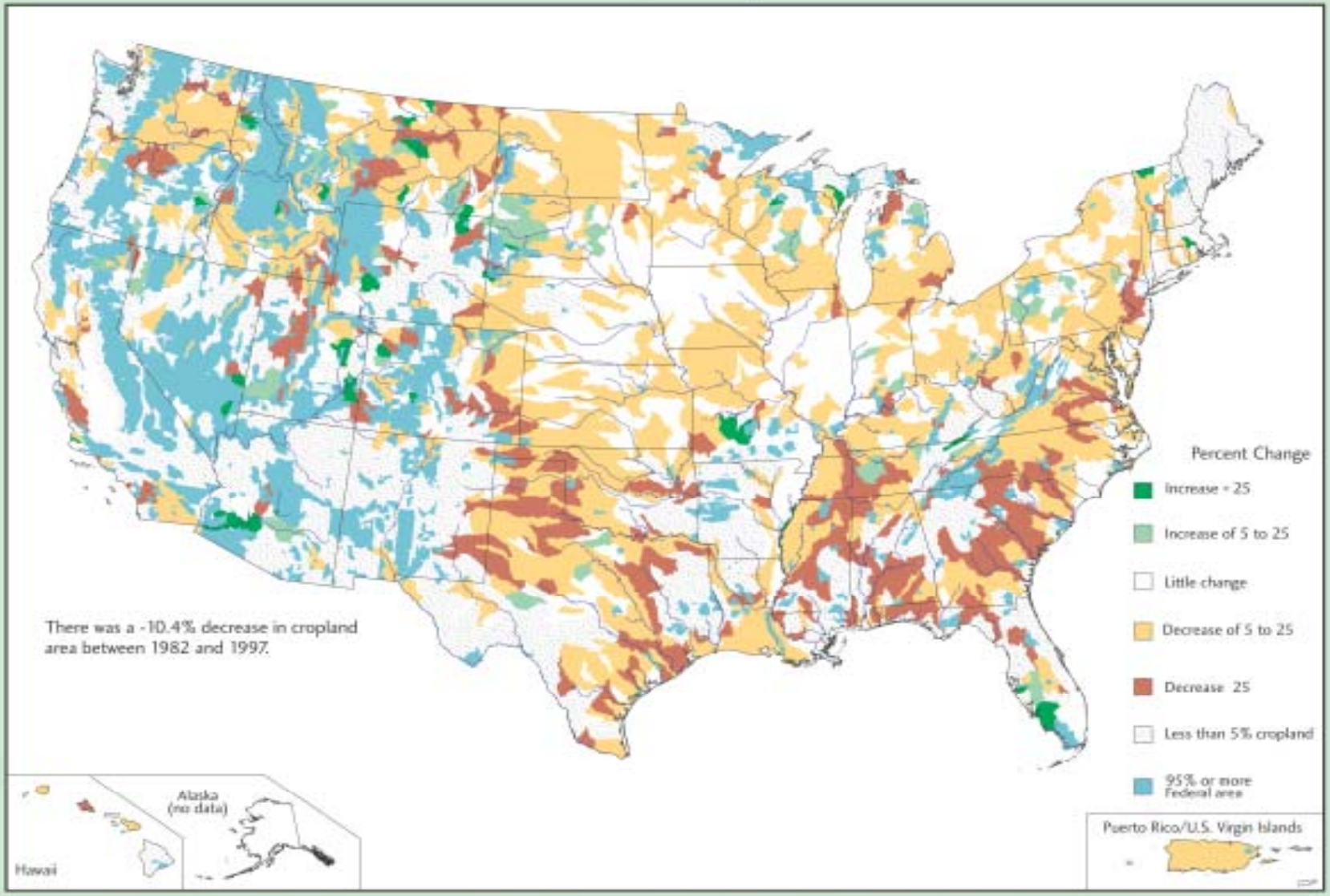

1982–01: 18% decrease

1992–01: 3% decrease

Coverage: 379 monitoring sites nationwide with sufficient data to assess trends.

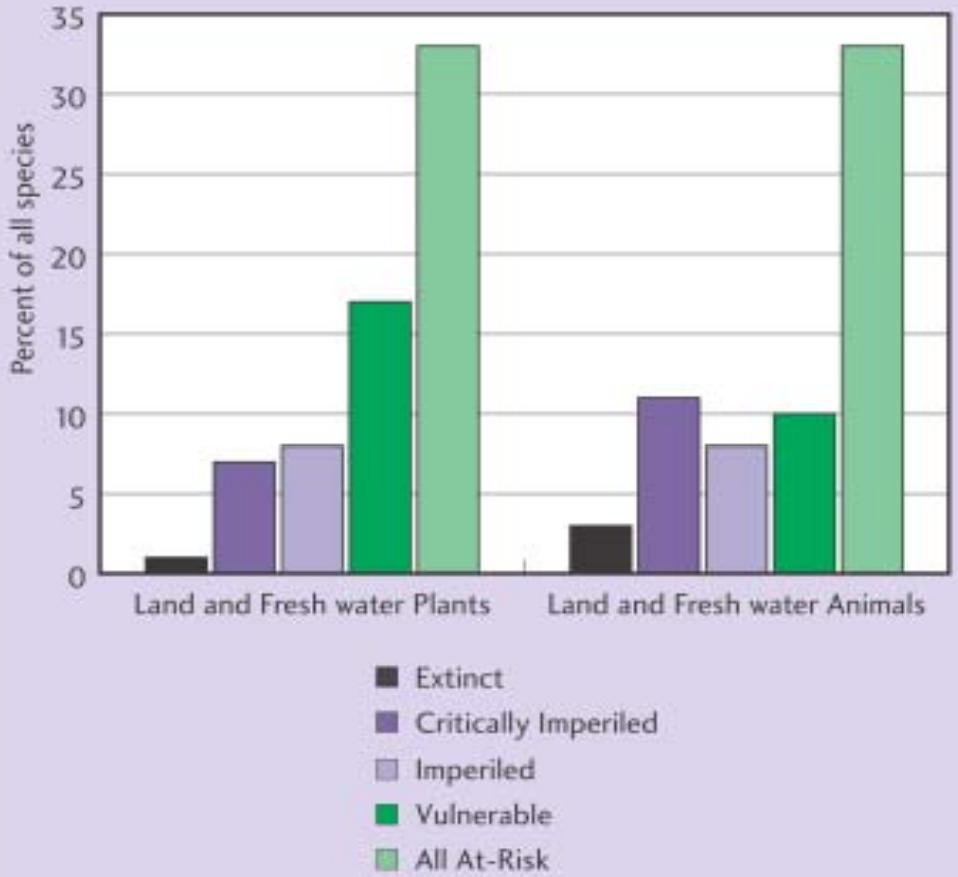
Source: EPA, Office of Air Quality Planning and Standards. *Latest Findings on National Air Quality: 2001 Status and Trends.* September 2002.

# Exhibit 3-8: Percent change in cropland area, 1982-1997




Source: USDA, Natural Resources Conservation Service. National Resources Inventory, 1997, revised December 2000: Percent Change in Cropland Area, 1982-1997, 2000. (January 2003; www.nrcs.usda.gov/technical/land/meta/m5874.html).

## Exhibit 5-40: At-risk land and fresh water plant and animal native species, 2000




Coverage: all 50 states.

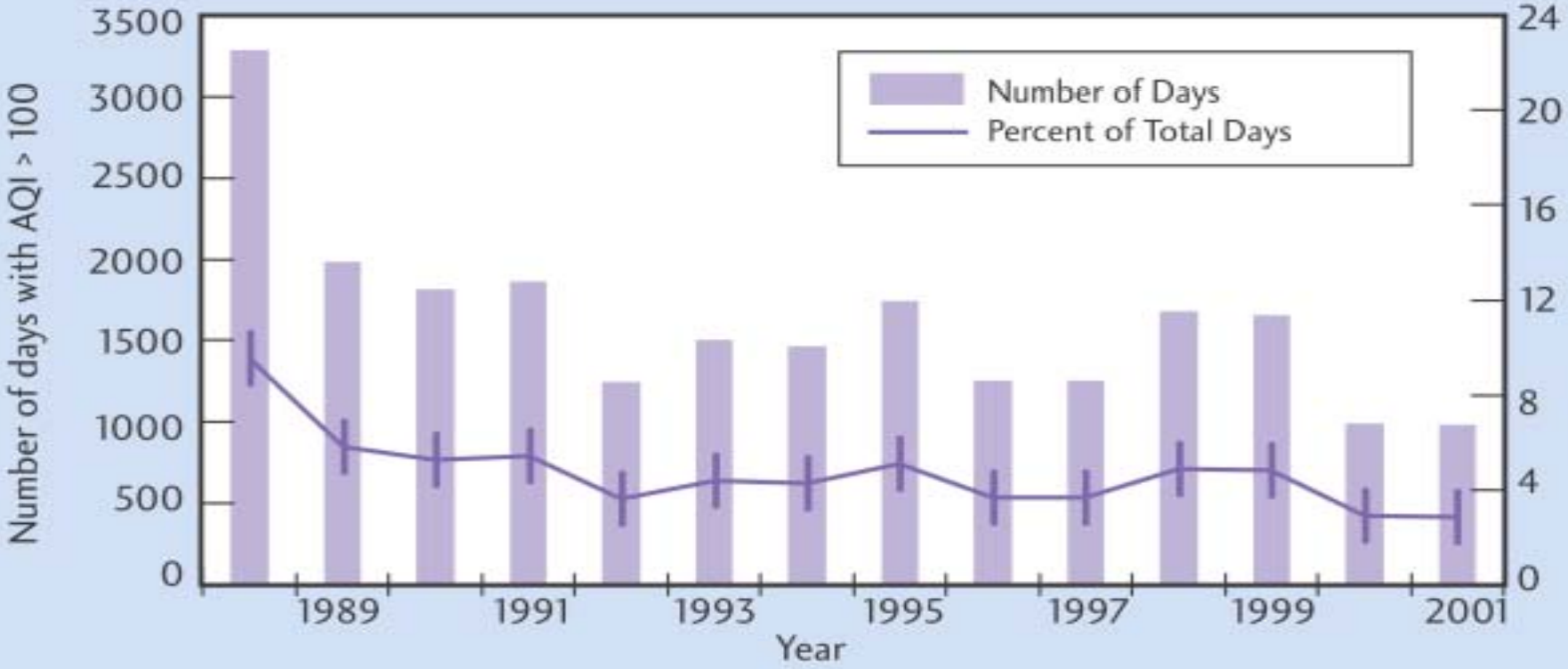
Source: The Heinz Center. *The State of the Nation's Ecosystems*. 2002. Data from NatureServe and its Natural Heritage member programs.

# *Transparency*

- The “meaning” of a performance indicator and the details of its construction must be clearly evident to the user
- Important limitations of the indicator should be clearly identified

# More examples

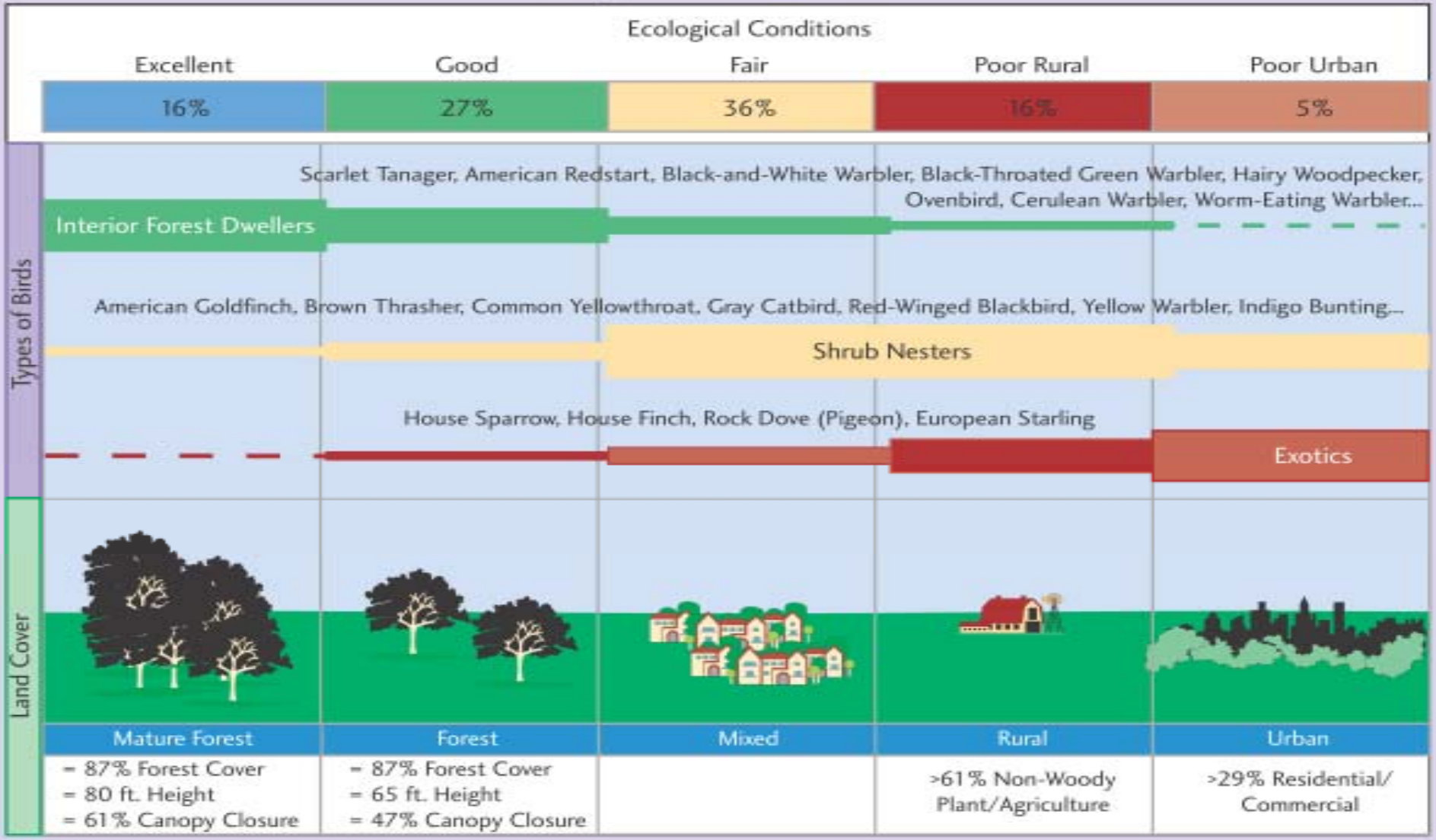
# Exhibit 1-4: Number and percentage of days with Air Quality Index (AQI) greater than 100, 1988-2001




Note: Data are for MSAs > 500,000

Source: Data used to create graphic are drawn from EPA, Office of Air Quality Planning and Standards. *National Air Quality and Emissions Trends Report*, 1997. Table A-15. December, 1998; EPA, Office of Air Quality Planning and Standards. Air trends: Metropolitan area trends, Table A-17, 2001. (February 25, 2003; *http://www.epa.gov/airtrends/metro.html*).

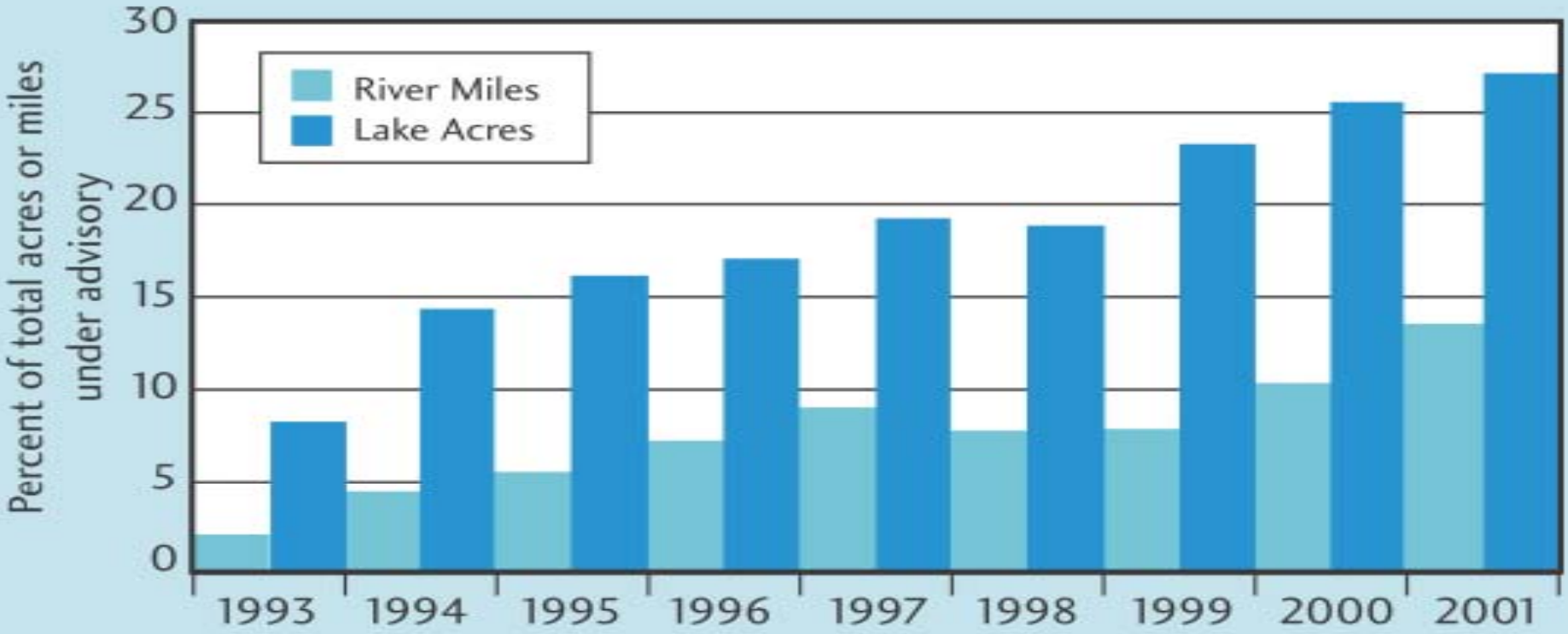
# Exhibit 5-41: Bird species as characteristics of landscape composition and pattern as an indicator of landscape condition, 1995-1996




Coverage: Mid-Atlantic Highlands (Maryland, Pennsylvania, Virginia, West Virginia).

Source : EPA, Office of Research and Development. *Birds Indicate Ecological Condition of the Mid-Atlantic Highlands*. June 2000.

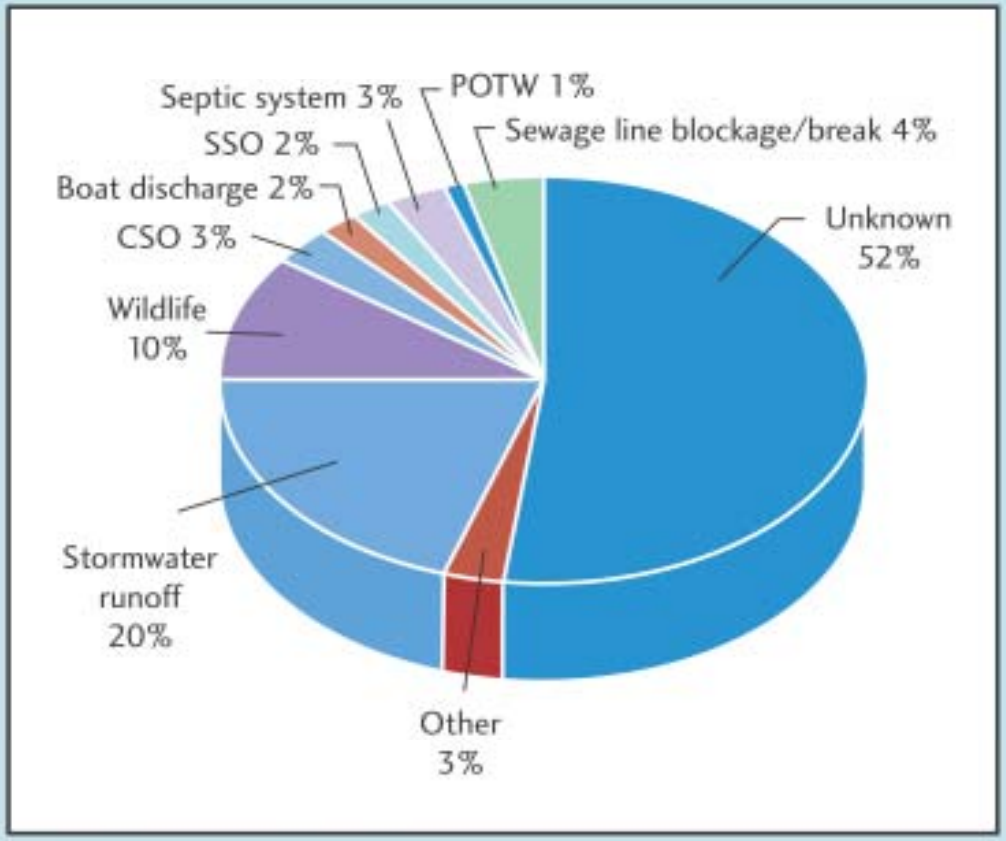
# Exhibit 2-33: Trends in percentage of river miles and lake acres under fish consumption advisory, 1993-2001




Coverage: all 50 states

Source: EPA, Office of Water. *Update: National Listing of Fish and Wildlife Advisories.* May 2002.

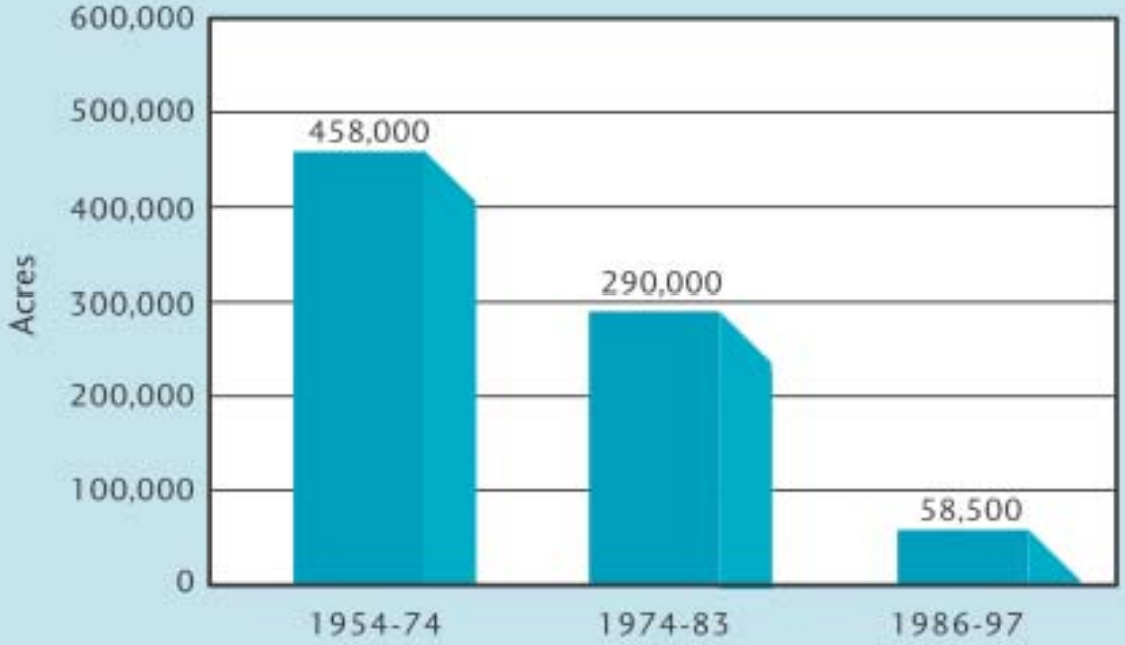
## Exhibit 2-32: Reported sources of pollution that resulted in beach closings or advisories, 2001




CSO - Combined Sewer Overflow
SSO - Sanitary Sewer Overflow
POTW - Publicly Owned Treatment Works

Source: EPA, Office of Water. *EPA's BEACH Watch Program: 2001 Swimming Season.* May 2002.

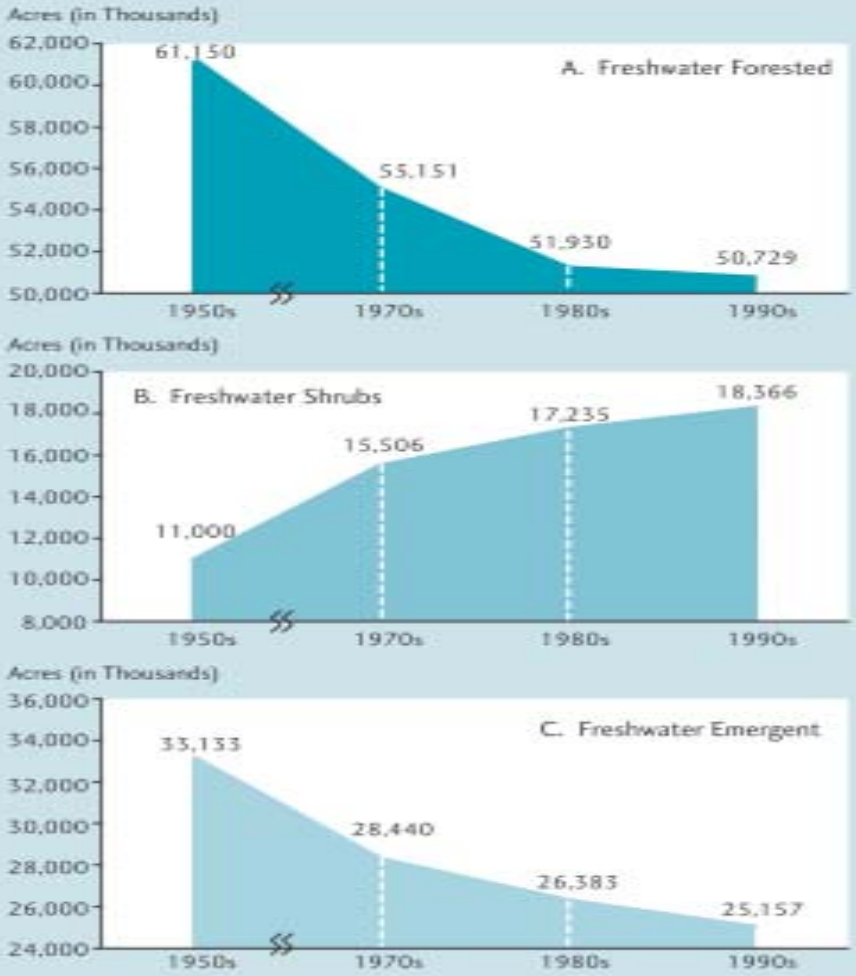
# Exhibit 2-5: Average annual wetland loss, 1954-1974, 1974-1983, 1986-1997




Coverage: Conterminous United States

Source: Frayer et al. *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950s to 1970s.* 1983; Dahl, T.E. and C. E. Johnson. *Wetlands Status and Trends in the Conterminous United States: 1970s to 1980s.* 1991; Dahl, T. E. *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997.* 2000.

## Exhibit 2-6: Long-term trends in selected freshwater wetlands, 1954-1997

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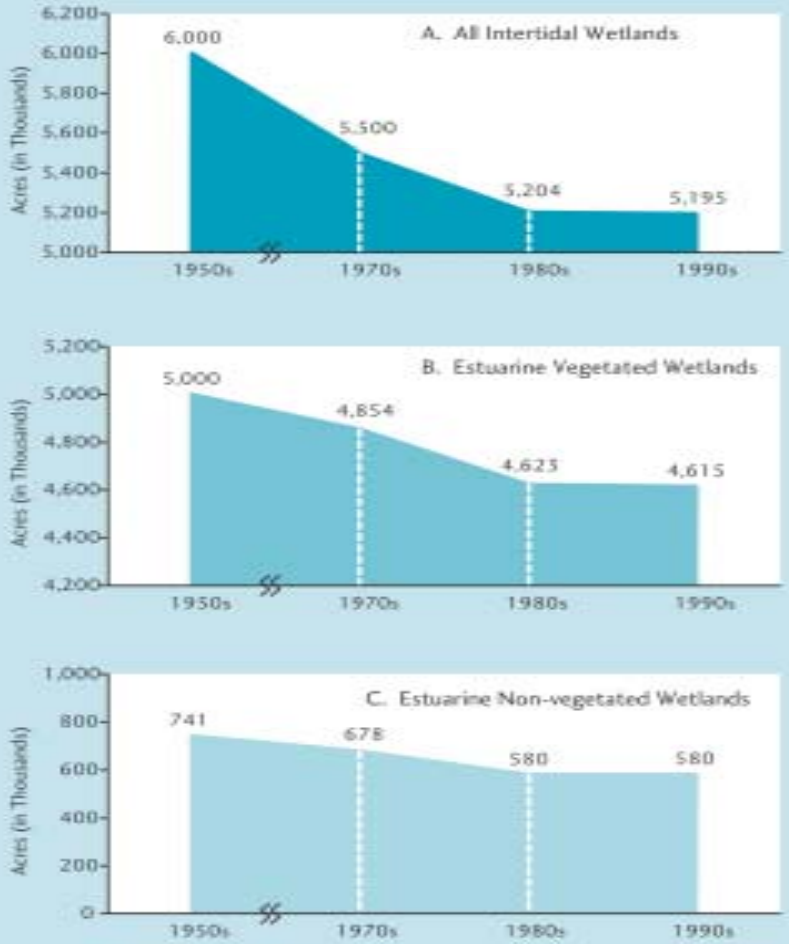
## Exhibit 2-7: Long-term trends in selected estuarine wetlands, 1954-1997




Coverage: Conterminous United States

Source: Frayer et al. *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950s to 1970s.* 1983; Dahl, T.E. and C. E. Johnson. *Wetlands Status and Trends in the Conterminous United States: 1970s to 1980s.* 1991; Dahl, T. E. *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997.* 2000.

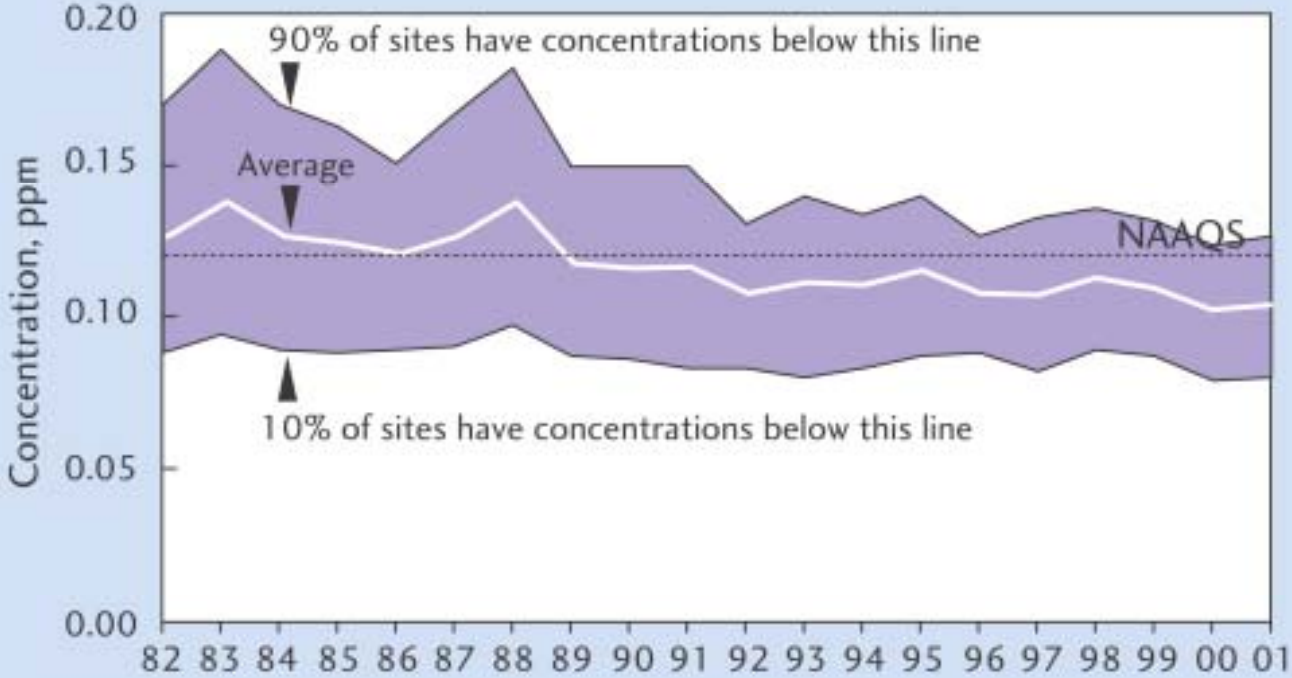
# *Reference states*

- What constitutes good, fair, and poor performance?
  - Adherence to standards
  - Indices and reference sites
  - Trends in population distributions

# More examples

# Exhibit 1-10: Ozone air quality, 1982-2001

## based on annual 2nd maximum 1-hour average



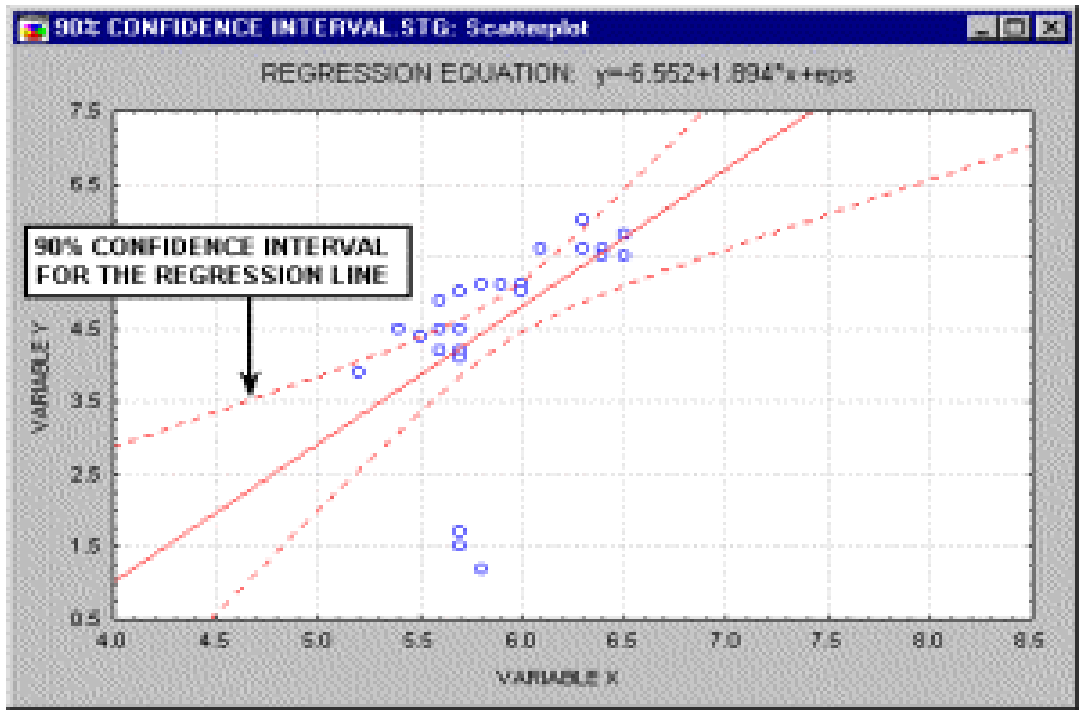

1982–01: 18% decrease

1992–01: 3% decrease

Coverage: 379 monitoring sites nationwide with sufficient data to assess trends.

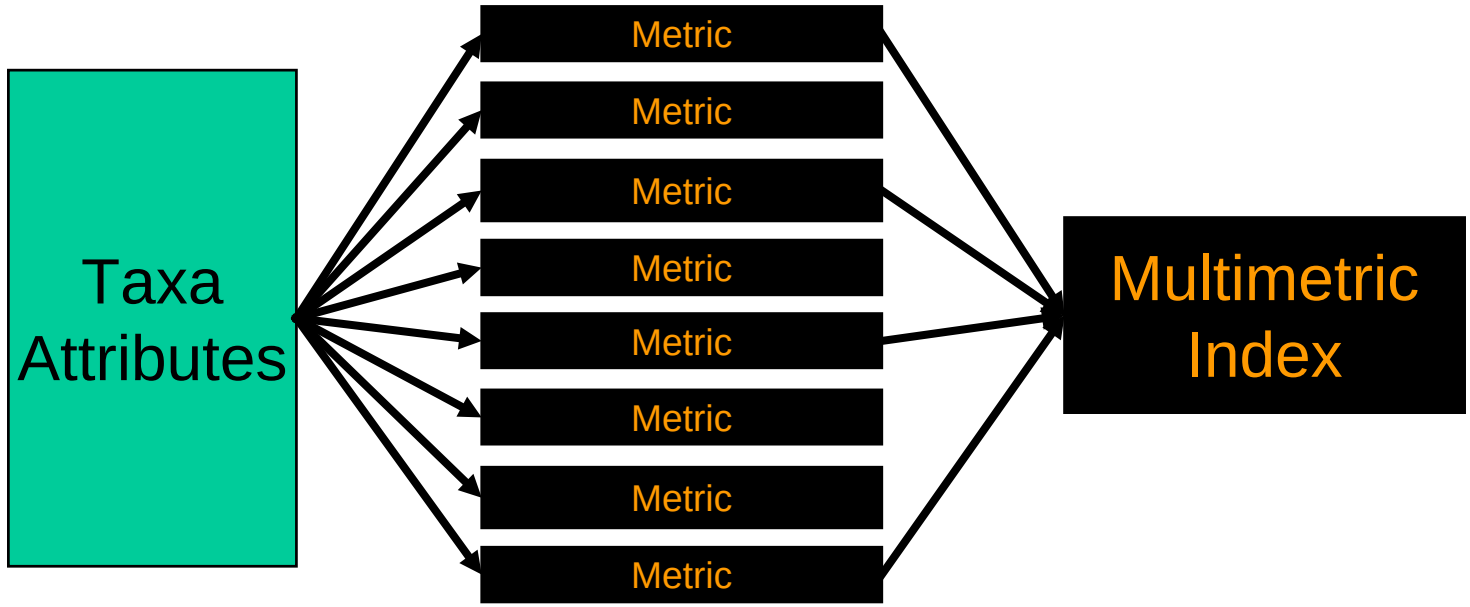
Source: EPA, Office of Air Quality Planning and Standards. *Latest Findings on National Air Quality: 2001 Status and Trends.* September 2002.

# The dangers of trends in extreme values



# Multimetric Indices (IBI)

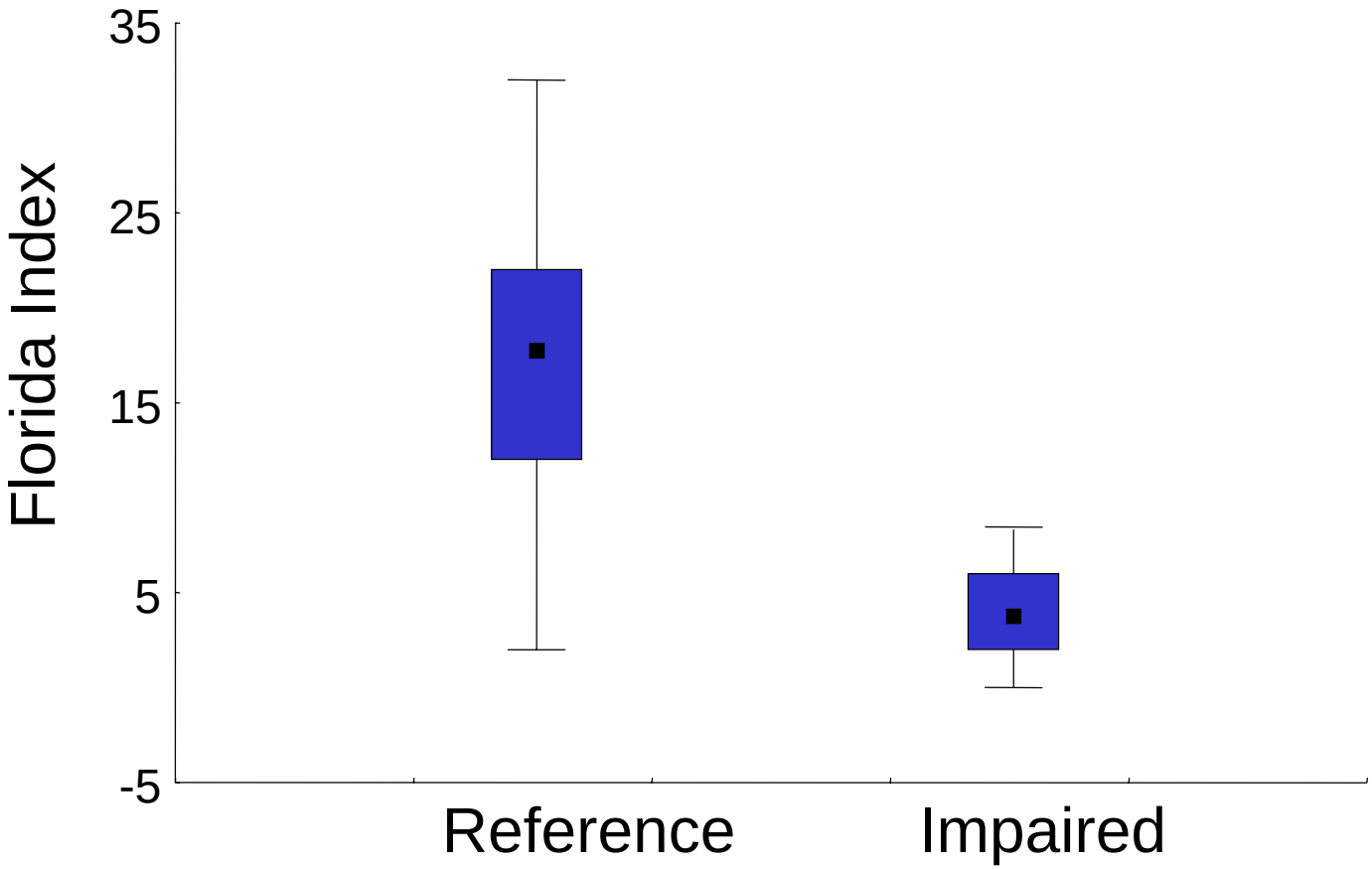
Incorporate several attributes (metrics) reflecting 'biological integrity' into one synthetic multimetric score



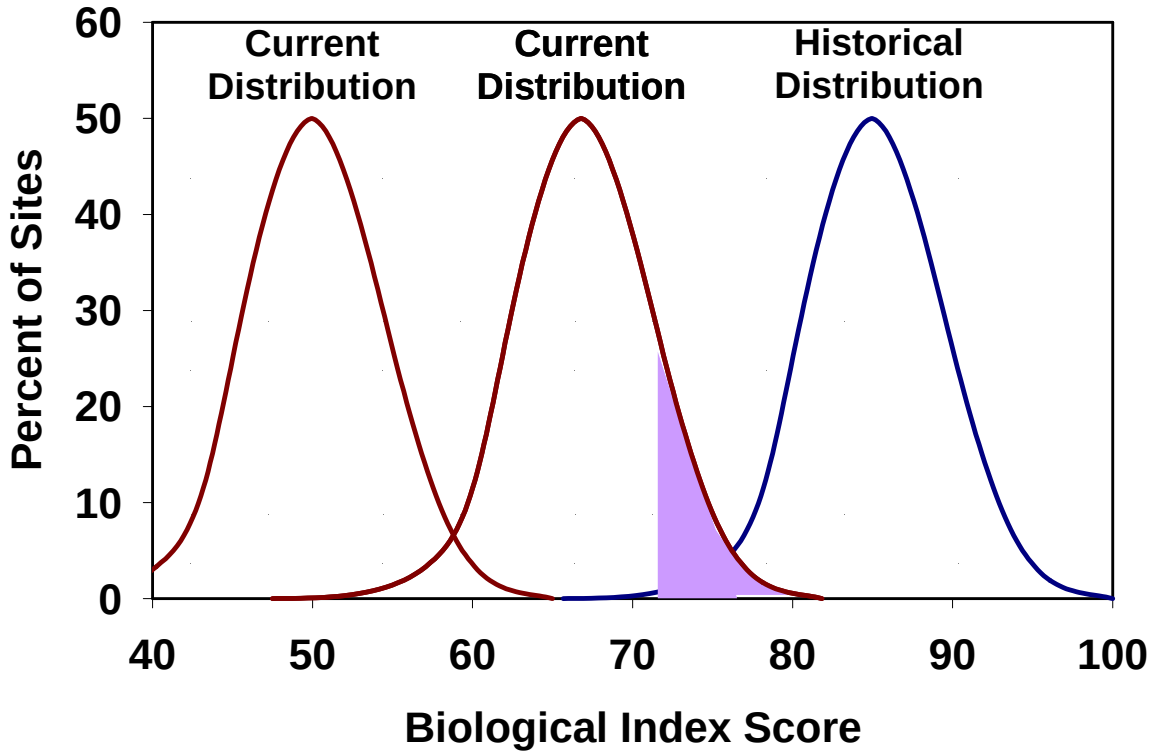
# Reference Sites

- The primary function of a reference site is to serve as a measurement standard
  - undisturbed, natural
  - best of available
  - representative of class

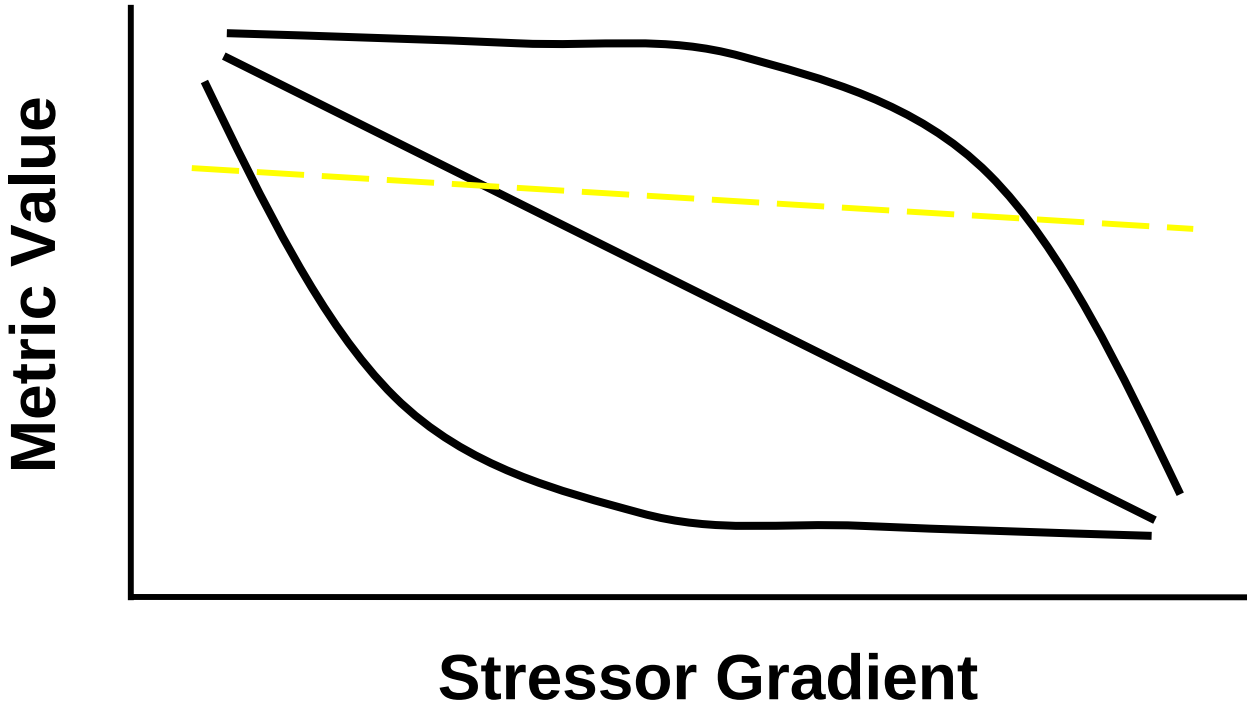
# Florida Index: Reference vs. Impaired



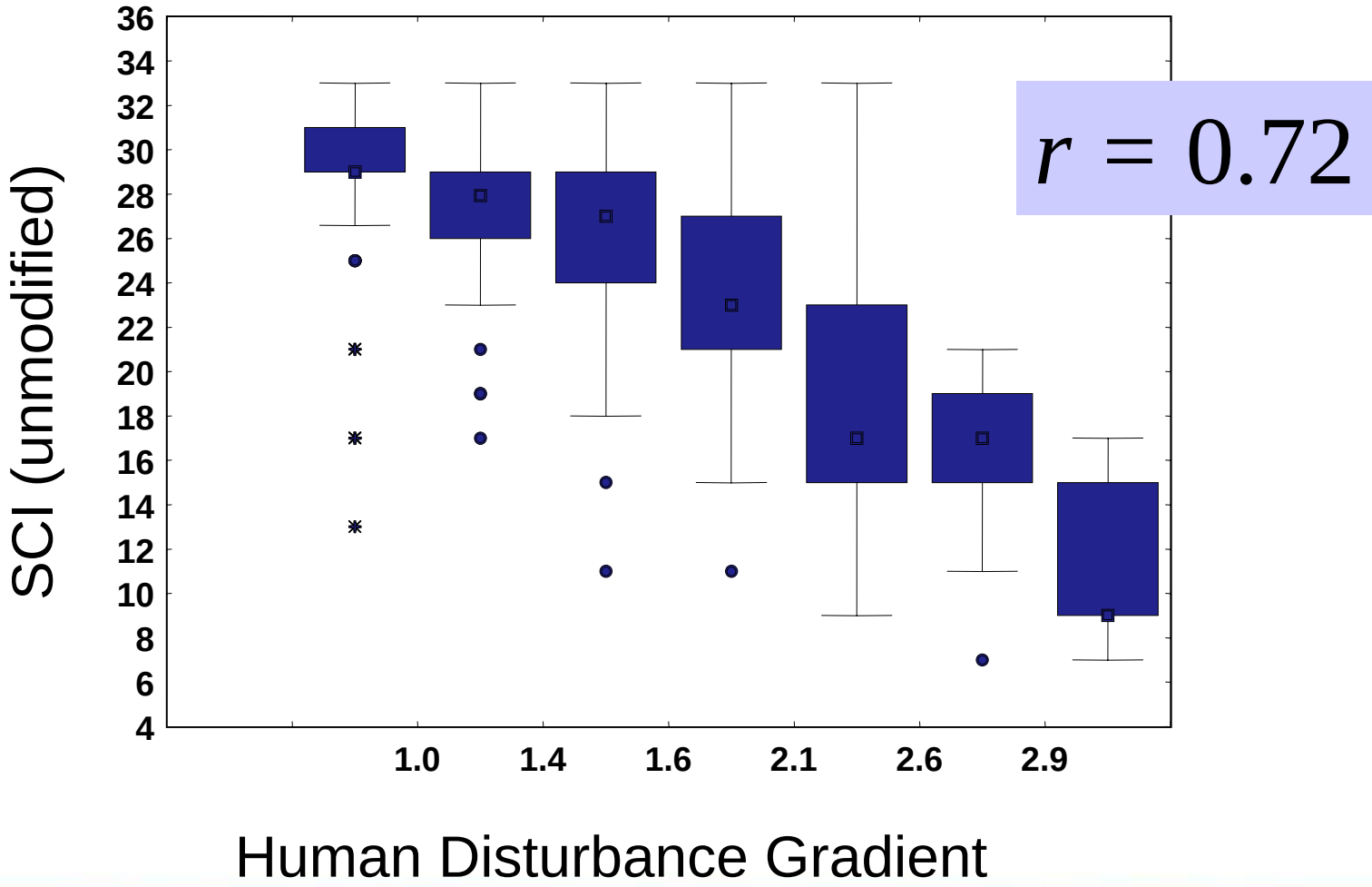
# Estimating distribution of sites in reference condition



# *Multimetric indices vs gradients*



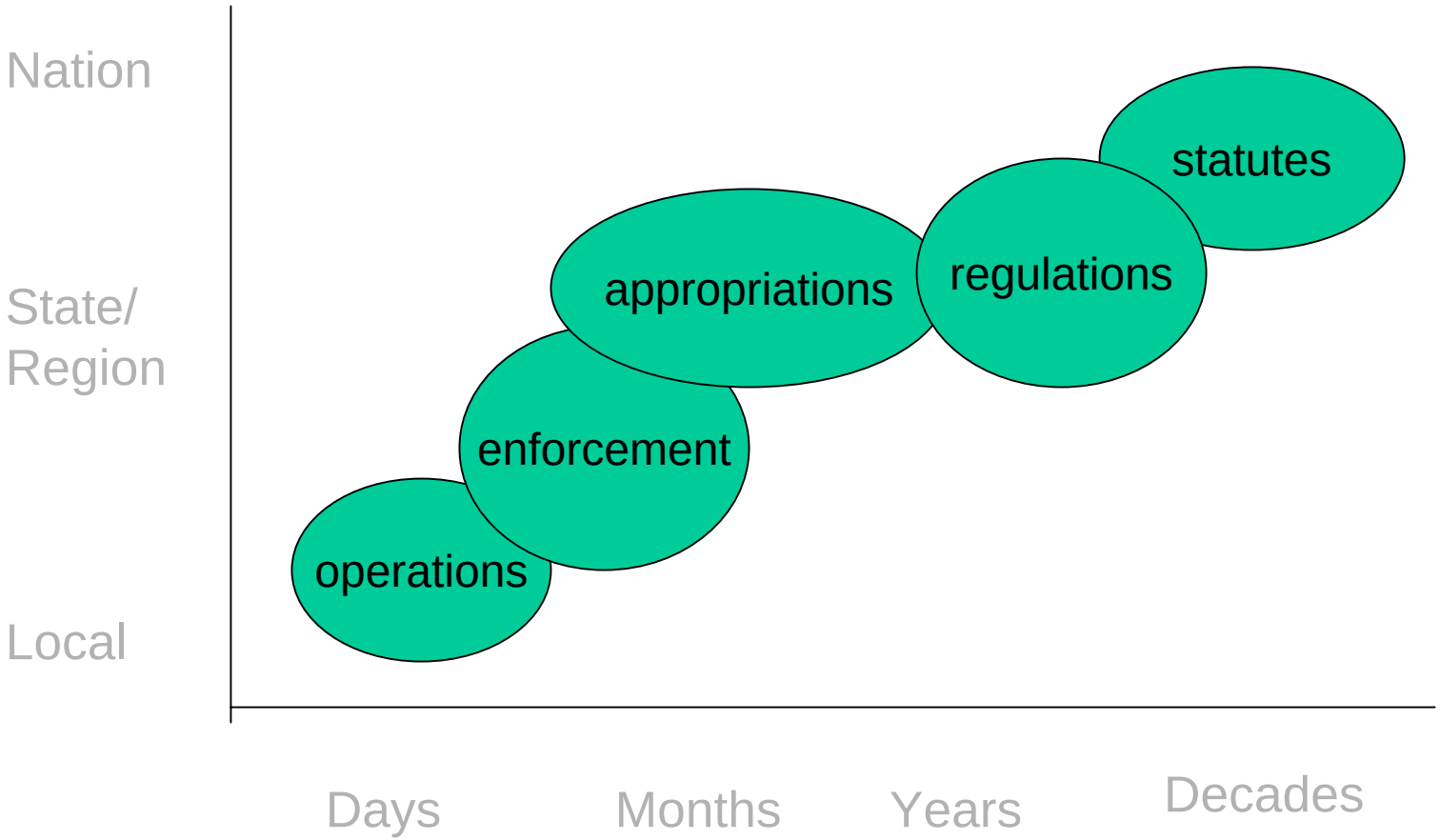
# Florida Stream Quality Index vs. Human Disturbance Gradient



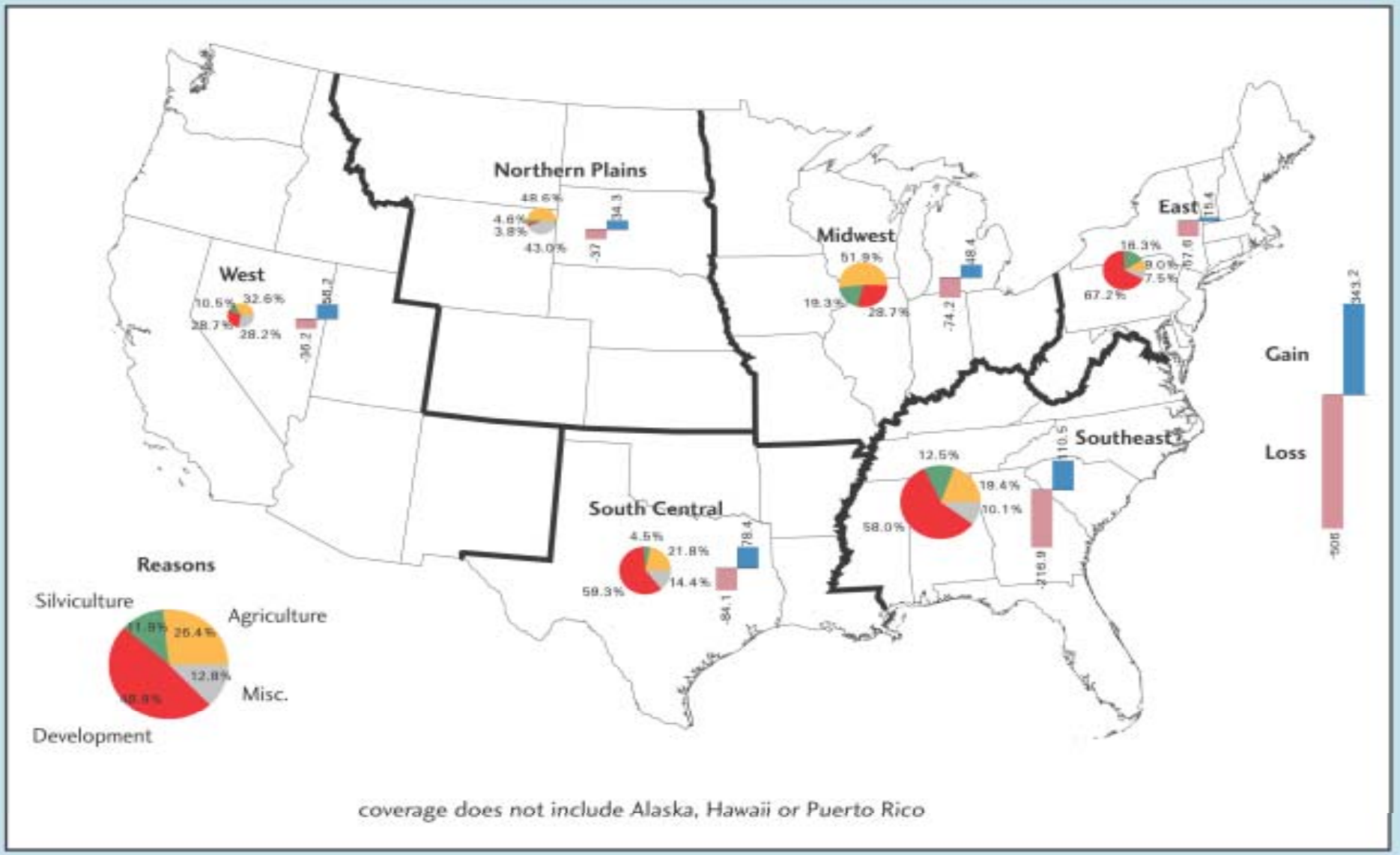
# *Appropriate scale*

- Are we measuring performance
  - For a family?
  - For a community?
  - For a State or Region?
  - For the Nation?
  - For the globe?
- Each target is likely to require an indicator with a different time and space scale.

# *Hierarchy and Scale*



# Exhibit 2-8: Non-Federal wetland losses and gains and reasons for conversion, 1992-1997




coverage does not include Alaska, Hawaii or Puerto Rico

Source: *Summary Report: 1997 National Resources Inventory (Revised December 2000)*. 2000.

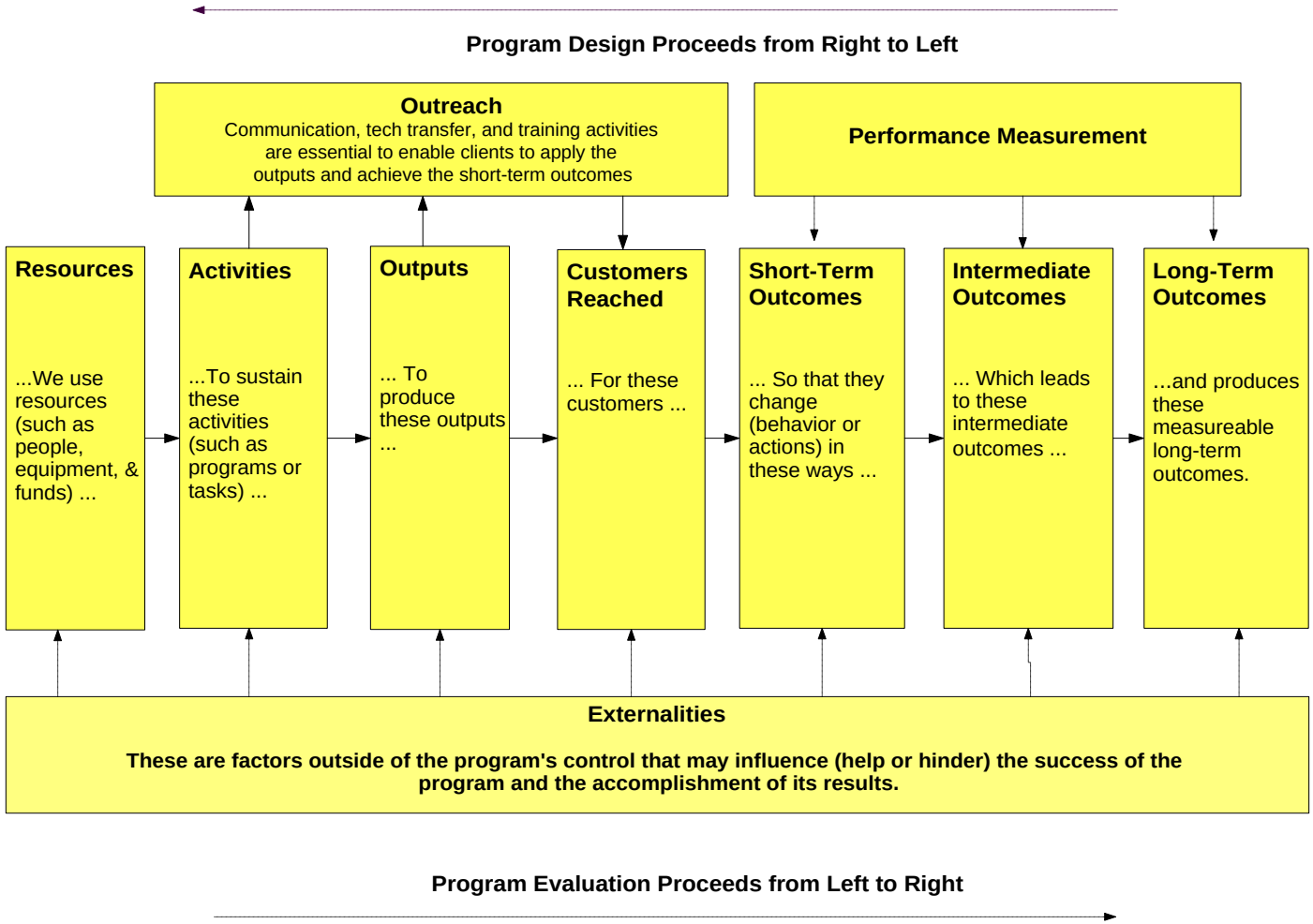
# *Data quality and access*

- Information Quality Guidelines
- Documentation of QA plans and performance
- Public access to data to ensures credibility

# *Challenges to the timeliness of indicators*

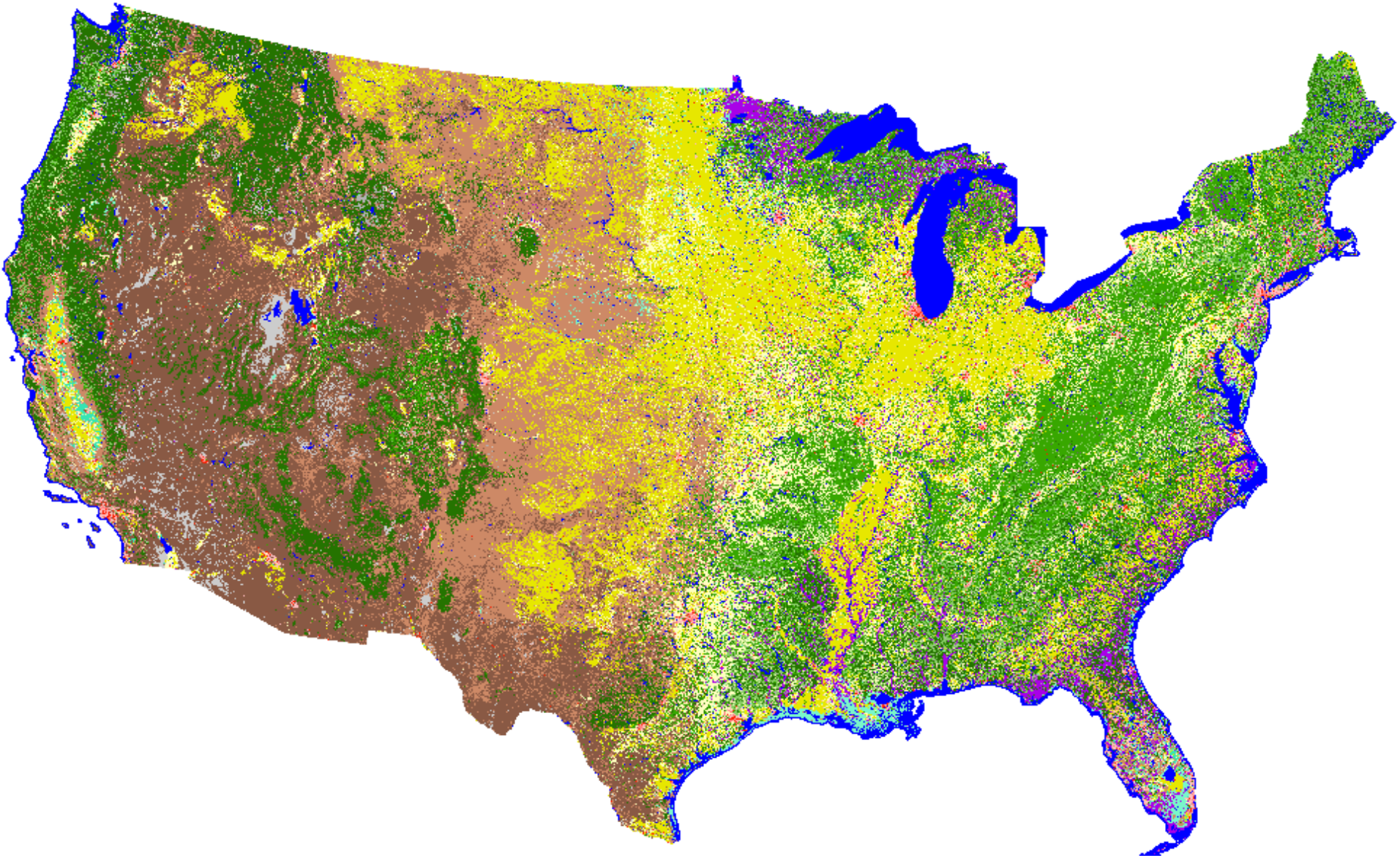
- Trends in “outcomes” often lag behind current budget planning and execution

# The Logic Model

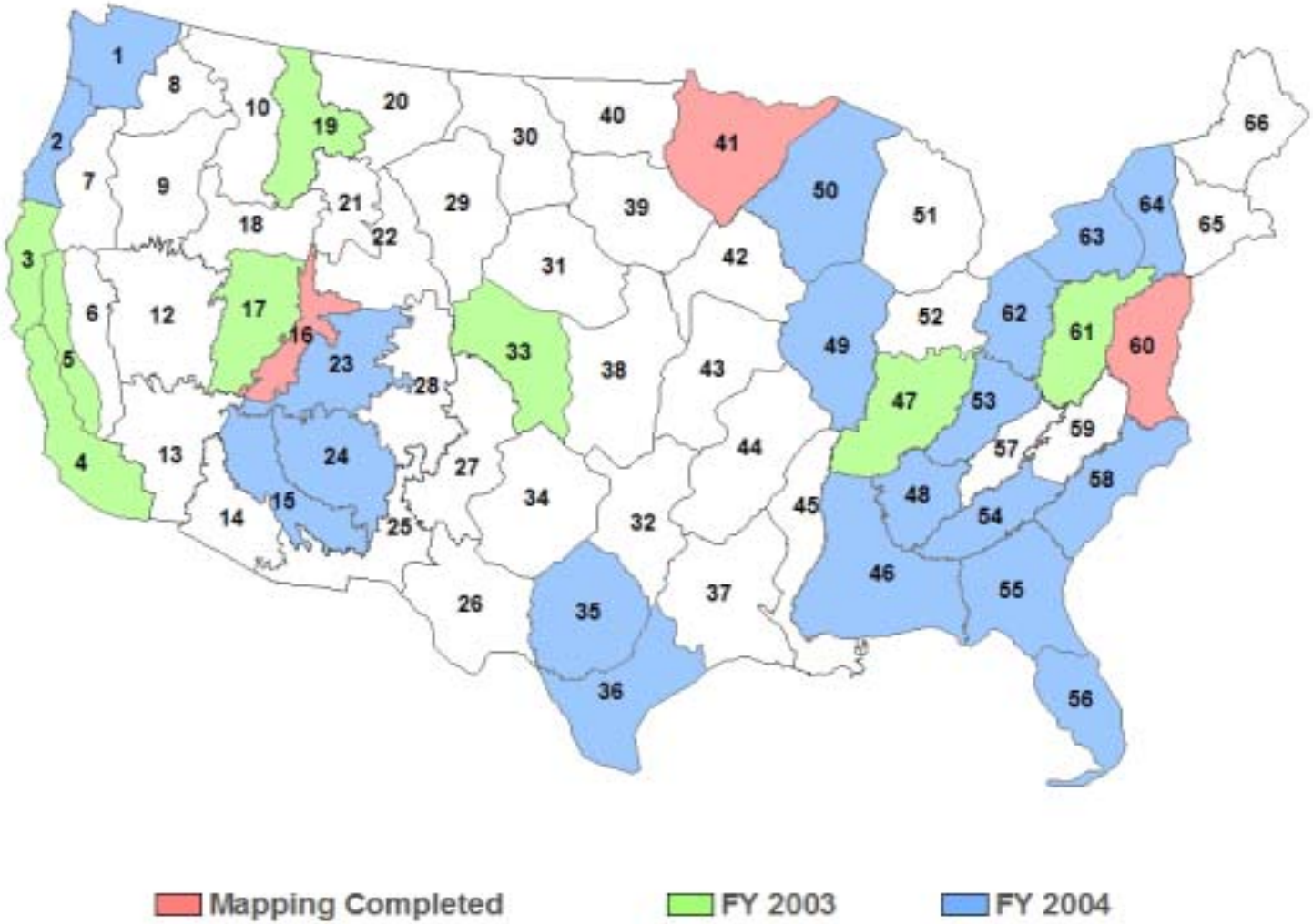


# *Challenges to the timeliness of indicators*

- Aging data (e.g., National Land Cover Dataset)



# NLCD -2001 Draft Mapping Zone Plan, By Fiscal Year



# *Challenges to the availability of performance data*

- Cost – Performance monitoring requires resources - organizations won't invest if they don't see a payoff
- Cooperation – Performance monitoring requires a joint effort by State and Federal partners.

# Exhibit 5-44: Distribution of available ecological condition indicators across the ecosystem types

| Essential Ecological Attribute | Forests | Farmlands | Grasslands/ Shrublands | Urban/ Suburban | Fresh Waters | Coasts and Oceans | The Nation |
|---|---|---|---|---|---|---|---|
| **Landscape Condition** | | | | | | | |
| Extent of Ecological System/Habitat Types | 1 1 | 1 | 1 | 1 | 1 1 | 1 | 1 |
| Landscape Composition | 2 | 1 | | 2 | 2 | 2 2 | |
| Landscape Pattern/Structure | 2 | | | | | | |
| **Biotic Condition** | | | | | | | |
| Ecosystems and Communities | 2 | | 1 2 | | 2 2 2 2 2 | 2 2 2 | 2 |
| Species and Populations | 2 | | | | 2 | 2 | 2 |
| Organism Condition | 1 2 2 | | | | 2 | 2 2 | |
| **Ecological processes** | | | | | | | |
| Energy Flow | | | | | | | 1 |
| Material Flow | 2 | | | | | | 1 |
| **Chemical & Physical Characteristics** | | | | | | | |
| Nutrient Concentrations | 2 | 2 2 | | 2 2 | 2 2 | 2 2 | |
| Other Chemical Parameters | 2 2 | | | | 2 | 2 2 | |
| Trace Organic /Inorganic Chemicals | | 2 2 2 2 | | 1 2 | 2 | 2 2 | 2 |
| Physical Parameters | 2 | | | | | 2 | |
| **Hydrology and Geomorphology** | | | | | | | |
| Surface and Ground Water Flows | 1 | | 1 | | 1 | | |
| Dynamic Structural Conditions | | | | | | | |
| Sediment and Material Transport | 2 | 2 2 | | | 2 | | |
| **Natural Disturbance Regimes** | | | | | | | |
| Frequency | 2 | | | | | | |
| Extent | | | | | | | |
| Duration | | | | | | | |

Note: Numbers correspond to indicator categories presented in this report.

# *Recommendations*

- Use multiple indicators across the hierarchy to help to close the gap between actions and outcomes
- Gaps and limitations are unavoidable – making them explicit increases transparency
- Showing that indicators make a difference is the key to investment

# *Performance Indicators - Are they worth it?*

- Performance indicators enhance the public dialog about the state of the environment
- Performance indicators focus the need for more in-depth analysis of program performance.